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Characterization of Diesel Emissions as a Function of Fuel Variables

Southwest Research Inst.
San Antonio, TX

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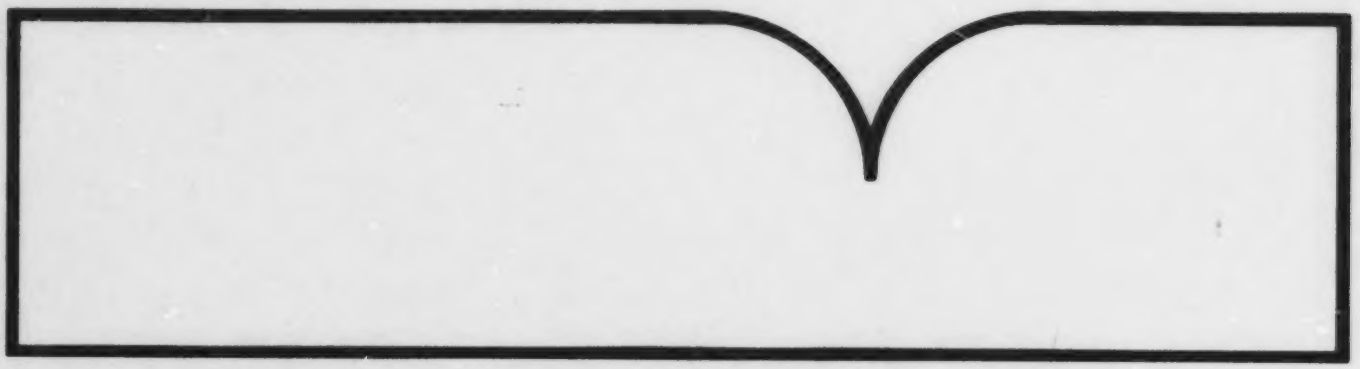

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Several properties of a refinery "straight-run kerosene", which had a narrow boiling range approximating the middle of a No. 1 diesel fuel, were altered to study their effects on regulated and unregulated exhaust emissions. Eleven fuel blends, representing changes in nitrogen content, aromatic level, boiling point distribution, olefin content, and cetane number, were evaluated in a 1975 Mercedes-Benz 240D. Statistical analysis, including regression, was performed using selected fuel properties as independent variables. Higher aromatic levels were generally associated with increased emissions, while increased olefin levels were generally associated with decreased emissions.

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Prepared for

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April 1981

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ABSTRACT

This report describes the laboratory testing of several diesel fuel blends in a 1975 Mercedes 240D. A narrow-cut base fuel's properties were altered to study the effects of fuel composition on gaseous and particulate emissions. Eleven fuel blends were investigated, representing changes in nitrogen content, aromatic level, boiling point distribution, olefin content, cetane number, and other properties.

Vehicle operating procedures used for test purposes included both those specified in Federal Regulations (FTP)[1]* and occasionally an 85 km/h cruise simulation. Both regulated and unregulated gaseous and particulate emissions were measured using a CVS-PDP and dilution tunnel operating on the entire exhaust stream of the engine. The majority of the sampling and analytical procedures used were developed during earlier EPA Contracts 68-02-2497[2], 68-02-1230[3,4], and 68-02-1777.[5] A statistical analysis, similar to that performed under Contract 68-03-2440[6], was conducted on the gaseous and particulate emissions as a function of fuel properties.

*Numbers in parentheses designate references at the end of this report.

FOREWORD

This project was conducted for the U.S. Environmental Protection Agency by the Department of Emissions Research, Southwest Research Institute. The laboratory testing phase of the project began in September 1979, and was completed in March 1981. This project was conducted under EPA Contract No. 68-03-2707, and was identified within Southwest Research Institute as Project 11-5423-001. The EPA Project Officer was Thomas M. Baines of the Emission Control Technology Division, Environmental Protection Agency, 2565 Plymouth Road, Ann Arbor, Michigan. The Southwest Research Institute Project Manager was Charles T. Hare, and Principal Investigator was Bruce B. Bykowski. Karl J. Springer was overall supervisor of the effort.

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I. INTRODUCTION

Light-duty diesel-powered vehicles are increasing in numbers, as an energy-conscious public turns to more fuel-efficient vehicles. Predictions of 20 percent diesel car market penetration in the U.S. by 1990 are not uncommon, so diesel cars are increasingly important as a pollution source. The world's supply of crude oil is also being depleted, creating incentives for discovery and utilization of alternate sources of fuel. These conditions also contribute to pressure for widening of present diesel fuel specifications, to make the most of available crude oil.

A number of studies have been performed to investigate the effects of commercially-available diesel fuels on exhaust emissions. A wide range of diesel vehicles, operated on both transient and steady-state cycles, have been researched by the scientific community. With the advent of alternate-source fuels (shale oil, coal, etc.) and the loosening of diesel fuel specifications, however, the need exists for data to determine what effects on exhaust emissions, if any, can be expected from altering fuel composition beyond normal specifications. The project reported here was one attempt to gather such data, utilizing a base fuel which was high in quality and petroleum-derived, with other materials added to determine their effects individually.

Selection of compounds and mixtures added to the base fuel was made on the basis of changes in emissions attributed to fuel properties in previous research. Substances added included nitrogen (two forms), aromatics (two forms), olefins, paraffins (to extend both lower and upper ends of the boiling range independently), and a nitrate-type cetane improver. A second fuel, without the above additives, was also tried, having gross properties similar to those of the base fuel, but having undergone drastically different refining and blending processes.

II. SUMMARY AND CONCLUSIONS

The major objective of this project was to study the effects of fuel composition on exhaust emissions from one diesel vehicle, a 1975 Mercedes-Benz 240D, operated mainly on the FTP schedule. A base fuel whose composition was altered by adding various materials produced fuel blends for test. Eleven test blends were used to study the effects of aromatics, olefins, nitrogen, light ends, heavy ends, and cetane number.

One of the major challenges in performing this work was acquisition of a clean, narrow-boiling-range diesel fuel to serve as a base, and the development of a technique to prepare desired blends using readily available compounds. In some cases, refinery products satisfied blending component needs; while in other cases, pure chemicals had to be used. The latter situation made it essential to maximize test efficiency because of the high cost of pure compounds. Best efficiency was achieved by integrating a number of sampling procedures into each test, and by reviewing data carefully before proceeding.

The test format was designed to provide the maximum amount of emissions characterization information with as many fuel blend variations as possible. Gaseous and particulate emissions collection and analyses were performed using techniques developed in earlier work. The experimental design permitted limited statistical analysis of fuel effects on emissions, but more levels of some of the variables would have been desirable for this purpose.

The most important observations and conclusions reached as a result of this project (not necessarily in order) are as follows:

1. An approximation of changes in boiling range of a distillate fuel due to the addition of specific hydrocarbons can be made mathematically with reasonably good precision, yielding the ability to blend to a detailed boiling range specification.

2. To get the most accurate assessment of a diesel fuel boiling range, especially at the extremes, it should be determined by ASTM-2887 (G.C.-simulated distillation) rather than ASTM-D86.

3. Regulated gaseous emissions were not strongly affected by the fuel variables studied. Hydrocarbon and CO emissions increased slightly with the pure aromatic and cetane-improved aromatic blends. The cetane-improved aromatic blend also resulted in a small NO_x increase.

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4. A "heavy aromatic" blend, EM-434-F, reduced individual (low molecular weight) hydrocarbon emissions, most notably ethane. The other aromatic blends, EM-460-F and EM-463-F, resulted in increased individual hydrocarbons of lower molecular weight.

5. Aldehyde emissions were largely unaffected by fuel changes, with the exception of fuel EM-405-F (base + isoquinoline at 0.1% N). The increase in aldehydes was substantial, but not completely understood. The light-end and heavy-end blends also resulted in slight aldehyde increases, but not of the magnitude observed with EM-405-F.

6. Phenol emissions were strongly affected by the shale oil blend, EM-430-F. They increased to over 60 times the level observed with base fuel EM-395-F. The only other pronounced increase in phenols occurred while testing EM-405-F, base + isoquinoline.

7. Experimental application of instrumental odor evaluations to dilute exhaust and transient cycles indicated low odor intensity for all the blends. Slight increases in odor intensity occurred with the "heavy-aromatic," olefin, and extended light-end blends.

8. Visible smoke production was both increased and decreased by the use of various fuel blends, as compared to baseline smoke. The olefin blend, EM-438-F, reduced smoke levels during five portions of the cold-start FTP. "Heavy aromatics" (in EM-434-F) caused the greatest smoke increase. Addition of a cetane improver to EM-434-F produced fuel EM-463-F, and it reduced initial cold-start smoke levels below those for base fuel. This same blend exhibited the highest smoke level, however, at the "164 second" acceleration. This result helps make sense of other results observed when the cetane improver was used showing that it enhanced starting and cold combustion, but probably degraded emissions performance under other conditions.

9. Particulate rates were reduced with the light-end blend and the olefin blend, by 14 percent and 6 percent, respectively. The two blends containing aromatics, EM-434-F and EM-460-F, were associated with increases in particulate emissions of about 27 percent. The cetane-improved aromatic fuel blend, EM-463-F, increased particulate emissions about 68 percent over those observed with base fuel EM-395-F. Heavy ends fuel EM-461-F apparently did not cause an increase in particulate emissions, as might have been expected.

10. Impactor data indicated that the majority of the particulate mass was under 0.08 μm in diameter. The portion of particulate matter larger than 0.08 μm was distributed in uneven fashion among the calibrated impactor plates with no trends apparent due to fuel changes.

11. Trace elements accounted for 0.6% to 2% of the particulate mass. The most interesting finding was the detection of silicon in the particulate matter (possibly finely-divided mineral impurity carried through refining) when shale oil blend EM-430-F was used.

12. Blends containing aromatics resulted in slightly less organic solubles extracted from particulate matter. Olefins, light ends, and heavy ends were associated with increases in amount of organic solubles.

13. No apparent increase in the nitrogen content of the organic solubles was observed with any of the blends compared to base fuel. It was initially supposed that the fuel blends containing nitrogen might increase nitrogen levels in the organic solubles, but the results did not support that supposition.

14. BaP emissions were generally low for the fuel blends tested, ranging from 0.25 to 0.96 µg/km. A slight reduction was associated with the olefin blend, EM-438-F. A significant increase, 3 times, was exhibited by the shale oil blend EM-430-F when compared to the base fuel EM-395-F.

15. Statistical analysis led to condensing the large number of fuel and emission variables to five orthogonal fuel variables and nine "most important" emission variables. The five fuel variables were aromatics, olefins, nitrogen, ASTM-D2887 end point, and gum levels. Emission variables included HC, CO, NO, fuel consumption, particulate mass, solubles, BaP, phenols, and aldehydes. Aldehydes, HC, CO, NO_x, fuel consumption, and phenols were not strongly related (in the linear sense) to these five fuel variables. Particulate mass, BaP, CO, and solubles could be estimated by linear equations whose R^2 values were between 0.79 and 0.85. These equations were marginal in that they did not represent a true population dispersion of "real world" variability in fuel composition.

16. Rank-ordering of nine selected emission variables and corresponding fuels revealed no clear trends. No one fuel blend consistently caused greatest emissions degradation, nor did any blend consistently improve emissions more than the others. Some of the fuel blends were associated with reductions in several of the selected emissions and with increases in others. For example, the olefin blend resulted in particulate mass, BaP, phenol, aldehyde, and CO reductions, but increased fuel consumption and HC emissions.

III. TEST VEHICLES AND FUELS

The major criteria used for selection of a test vehicle were availability, and the potential to utilize a data base acquired on the vehicle during previous studies. Fuel consumption criteria were variety in variables so as to be most orthogonal to each other, and maximum projected effect on particulate emissions and Ames bioassay results.

A. Test Vehicle

The vehicle chosen was a 1975 Mercedes 240D. A description of the vehicle is provided in Table 1. This Mercedes was supplied to the Contractor by EPA for test purposes and was used in earlier EPA Contracts 68-03-1777[5], 68-03-2440[6] and 68-02-2116.[7]

TABLE 1. DESCRIPTION OF TEST VEHICLE

Vehicle model	Mercedes 240D
Engine model	OM616
Model year	1975
V.I.N.	11511710066208
Engine no.	616916-10-052895
Body type	4 door sedan
Loaded weight, kg (lb_m)[a]	1492 (3289)
Inertia equivalent, kg (lb_m)	1588 (3500)
Transmission	4 speed manual
Displacement ℓ(in^3)	2.40 (146.7)
Cylinders	4
Power, kW (hp) @ rpm	46.2 (62) @ 4350
Injection system	Bosch
Combustion chamber	prechamber
Compression ratio	21.0
Distance on vehicle, km[b]	14991

[a] curb weight plus 136 kg (300 lb_m)
[b] at end of project

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B. Test Fuels

Criteria used for selection of a base diesel fuel were high paraffin content, low sulfur, low nitrogen, narrow boiling range, and ready availability. The original base fuel candidate was a JP-7 material, which is a highly-hydrotreated fuel designed for use in high-aititude reconnaissance aircraft. The JP-7 approximated a No. 1 diesel or Jet A in boiling range, and analyses indicated that this fuel met the criteria. Although the specifications of the JP-7 fuel were not classified, the fuel itself was restricted in its distribution and use to approved military customers in tank car (114,000 ℓ) lots. Efforts were redirected to find a commercially available substitute.

A local refiner and supplier of technical fuel, Howell Hydrocarbons, had some fuels available which were normally used as blending components. One such material, their code H320, was comparable to the JP-7. Approximately 1100 liters was obtained for use as base fuel. Contact with Mr. Art Churchill at Wright Patterson AFB resulted in procurement of 1100 liters of JP-7 with the proper paper work. The JP-7 was coded at SwRI as EM-401-F and was set aside for testing as an alternate base fuel. The Howell material, H320, was coded EM-395-F, and was chosen as the base fuel because of its narrower boiling range and lack of additives (which the JP-7 was permitted to contain). An additional 10,000 liters of Howell H320 was obtained after analysis was complete.

The initial fuel compositions were to be a "clean" base fuel, and base fuel with two added levels of three materials having substantial nitrogen content. Results from Contract 68-03-2440[6] indicated that fuel nitrogen was a good place to start in observing quantitative effects, especially on particulate mass and Ames bioassay results. Nitrogen was also quite well adapted to control as a variable, since it was not detected in the base fuel. Substantial changes in fuel nitrogen content were to be made with only very small corresponding changes in other variables. The planned initial fuel compositions containing nitrogen are listed below:

Fuel	Composition
1	base, N level approximately 0.005%
2	base + refinery bottoms, N level 0.04%
3	base + refinery bottoms, N level 0.1%
4	base + acridine, N level 0.04%
5	base + acridine, N level 0.1%
6	base + benzoquinoline, N level 0.04%
7	base + benzoquinoline, N level 0.1%

Later review of the fuels above resulted in dropping mixtures using benzoquinoline, because of the unlikelihood that benzoquinoline is present in diesel fuel and the hazards of handling a known mutagen as a fuel component. Small test blends of base fuel (EM-395-F) and acridine were

prepared to determine its suitability. All the test blends incorporating acridine were somewhat turbid, had a yellow color, and blends with 0.1 percent nitrogen or more crystallized at about 5°C. Potential substitutes for acridine were tetradecylamine and carbazole. Both substitutes had similar solubility problems. A number of other compounds were studied for potential use, but isoquinoline had the best combination of properties. Isoquinoline mixed clearly throughout the required ranges and had a low molecular weight similar to the base fuel. The 2-ring structure of isoquinoline is identical to quinoline (a compound suggested by the Project Officer based on discussion with DOE-BETC personnel) except for the position of the N substituent in the ring.

Test blends containing refinery bottoms also posed problems. Due to the extreme turbidity and partial insolubility of refinery bottoms, it was appropriate to set target nitrogen levels somewhat lower (0.004 to 0.01 percent N) than originally planned. In addition, a filtration step was added subsequent to fuel blending, but prior to fuel analyses. The analyses of initial refinery bottoms blends indicated extremely high gum values. Because of the likely detrimental effects and subsequent shifting of engine performance, the intended employment of refinery bottoms as a source of petrochemical nitrogen was in doubt.

A search was conducted to obtain a nitrogen compound similar to what might be present in refinery products, yet compatible with the base fuel. A gas chromatograph equipped with both a FID (flame-ionization detector) and a NPD (nitrogen-phosphorous detector) was incorporated to locate nitrogen compounds in various refinery products in relation to number of carbon atoms and subsequent boiling range. If the nitrogen was located in a relatively narrow boiling range, then the nitrogen-containing compounds could be concentrated by fractional distillation and used as an additive.

The initial candidate was a No. 2 diesel fuel used in a previous study.[6] This fuel contained 84 ppm nitrogen. The results indicated that a significant amount of nitrogen was not located in a very narrow cut. The nitrogen in this diesel fuel was located in the highest-boiling 20 percent "cut" and its distribution appeared to increase logarithmically with increasing carbon numbers and boiling temperatures. The refinery bottoms contained 1800 ppm nitrogen. Based on the finding of the No. 2 diesel fuel, an attempt was made to fractionally distill the first 80 percent of the refinery bottoms, leaving a remaining 20 percent that would contain the bulk of the nitrogen.

When attempting to vacuum-distill a 0-80 percent cut, it was noted that the boiling temperature reached 450°C after only 24 percent was distilled. This finding contradicted the ASTM-D86 boiling point distribution data of the refinery bottoms. The ASTM-D86 data indicated a boiling range for refinery bottoms of 300-404°C, with 10 percent residue. Distillation was halted at 450°C because the gum analytical procedure

(ASTM-D381) considers compounds remaining after 450°C is reached as gum. Apparently the boiling point distribution based on ASTM-D86 is not valid for high boiling materials, because this method can cause thermocracking of heavier constituents. This problem caused liquid materials to be collected that were not actually present in the initial sample. The gas chromatograph method of determining boiling points (ASTM-D2887) should therefore be used instead of ASTM-D86. In the 24 percent cut, very little nitrogen was detected. The use of refinery bottoms as a source of petrochemical nitrogen was not possible.

Discussion with Frank Newman of SwRI's Division 05 revealed that the nitrogen distribution increased logarithmically with increasing carbon numbers and boiling temperatures for most fuels that were subjected to various refinery processes (thermocracking, hydrogenation, etc.). Fuels that were essentially straight runs probably contain several low boiling point nitrogen compounds. A sample of straight run shale oil containing 1.44 percent nitrogen was acquired and injected into the gas chromatograph equipped with the FID-NPD detectors. The resulting chromatogram is located in Appendix B, page B-2. The results indicated that the nitrogen was distributed quite evenly in this wide-boiling range (≈125 to 600°C) material. A fractional cut of this oil, with a boiling range of 250 to 275°C, was obtained by vacuum distillation to prevent thermocracking. This fractional cut approximated the boiling range of the base fuel, and analysis indicated that it contained 0.92 percent (9200 ppm) nitrogen. The additive was soluble in the base fuel, and therefore a cut of shale oil became the source of petrochemical nitrogen, replacing refinery bottoms.

Because of the uncertainty of success and the high cost of a large volume distillation, only a small amount of the shale oil cut was produced. This was sufficient to prepare one blend containing approximately 500 ppm nitrogen, which was coded EM-430-F. The isoquinoline was used to prepare two fuel blends containing approximately 500 ppm (EM-404-F) and 1000 ppm (EM-405-F) nitrogen. The analyses of these fuels and that of the base fuel, EM-395-F are listed in Table 2.

Fuel blending and several analyses were shared among the Department of Emissions Research, the Mobile Energy Division, and the Division of Engines, Fuels, and Lubricants of SwRI. Blends representing each fuel composition were made up in batches of about 30 liters each, assuming that enough fuel was available for vehicle fuel system purging, vehicle operation, fuel analyses, and extra fuel on hand for possible retests. Only in cases where the fuel additive was extremely costly or available in limited quantities were smaller batches blended.

The fuels containing nitrogen were blended and tested to satisfy the requirements of the "initial study". The "main study" proposed preparing fuel blends on an "as needed" basis to incorporate the experience and findings of fuel blends which have completed testing. The fuel

TABLE 2. FUEL PROPERTIES

Substance	H320 base fuel	JP-7	395-F + isoquinoline ≈0.05%N	395-F + isoquinoline ≈0.1%N	395-F + shale oil cut ≈0.05%N	395-F + ≈ 31% Exxon "HAN" heavy aromatics	395-F + ≈ 6% Chevron alpha olefins	395-F + light ends	395-F + 30% pure aromatics	395-F + heavy ends	434-F + 0.7 vol. % DII-3
Code (EM-	395-F	401-F	404-F	405-F	430-F	434-F	438-F	448-F	460-F	461-F	463-F
Cetane No. (D613)	62	55	62[b]	61	63	44	64	56	46	68	60
Cetane Index (D976)	58	56	57[a]	56	56	44	58	61	48	62	44
50% point, °F	420	430	418[b]	418	418	421	418	409	418	434	421
Gravity, °API @ 60°F	47.0	45.3	46.7[a]	46.4	46.2	40.1	47.0	49.3	42.1	47.5	40.0
Density, g/ml @ 60°F	0.793	0.800	0.794[a]	0.795	0.796	0.825	0.793	0.783	0.815	0.791	0.826
Carbon, wt. %	85.10	85.91	85.10[a]	85.09[a]	86.02	86.65	84.56	85.12	86.42	85.18	86.38[a]
Hydrogen, wt. %	14.66	13.81	14.63[a]	14.58[a]	13.80	13.11	13.81	14.57	13.37	14.47	13.08[a]
Oxygen, wt. %	--	--	--	--	<0.5	--	--	--	--	--	0.21[a]
Nitrogen, ppm (oxid. pyrolysis)	<1	<1	479	930	493	5	<1	--	<1	<1	718
Calculated H/C, numeric	2.05	1.92	2.04	2.05	1.91	1.80	1.95	2.04	1.84	2.02	1.80
Carbon No. range (G.C.)	10-14	9-15	10-14	10-14	11-15	10-16	11-14	9-14	10-15	11-17	10-16[b]
Aromatics, vol. %	5.8	2.7	6.1[a]	6.6[a]	8.8	31.5	6.8	4.9	32.1	5.1	30.8
Olefins, vol. % (D1319)	1.5	1.9	1.5[a]	1.5[a]	1.8	2.9	6.6	1.8	1.0	1.0	1.2
Paraffins, vol. %	92.7	95.4	92.4[a]	91.8[a]	89.4	65.6	86.6	93.3	66.9	93.9	68.0
Viscosity, cs @ 100°F (D445)	1.59	1.69	1.59[a]	1.58	1.59	1.51	1.55	1.40	1.47	1.74	1.51[a]
Gum, mg/100 ml (D481)	0.2	0.5	0.3[b]	0.6	14.3	2.4	1.1	0.8	1.4	1.4	2.4[a]
Boiling Range, °C (IBP-EP, D86)	203-252	193-261	194-253[b]	194-255	200-249	191-266	203-252	175-249	203-255	207-286	190-266[a]
10% point, °C	211	206	211[b]	210	210	206	210	189	209	216	206[a]
20% point, °C	212	210	212[b]	211	211	209	211	195	211	218	209[a]
30% point, °C	213	213	213[b]	212	212	211	212	201	212	219	211[a]
40% point, °C	214	217	214[b]	213	213	213	213	206	213	221	213[a]
50% point, °C	216	221	215[b]	214	214	216	214	209	214	223	216[a]
60% point, °C	217	224	217[b]	216	217	218	217	213	216	227	218[a]
70% point, °C	218	228	218[b]	218	219	222	219	210	218	231	222[a]
80% point, °C	221	233	221[b]	220	222	226	221	219	221	238	226[a]
90% point, °C	224	239	224[b]	224	228	234	224	223	224	251	234[a]
95% point, °C	228	244	228[b]	229	233	244	229	227	228	260	244[a]
Residue, wt. % (D86)	0.8	1.0	--	0.5	1.5	1.0	1.0	1.0	0.5	1.0	--
Boiling Range, °C (IBP-EP, D2887)	140-269	138-278	146-279[b]	154-294	145-265	194-283	184-270	147-265	179-264	183-303	192-283[a]
10% point, °C	197	184	197[b]	198	200	207	203	164	198	202	207[a]
20% point, °C	202	198	203[b]	204	208	215	210	181	206	211	215[a]
30% point, °C	208	207	209[b]	210	213	220	216	203	210	216	220[a]
40% point, °C	213	215	214[b]	215	217	225	222	211	216	219	225[a]
50% point, °C	217	223	218[b]	219	220	228	226	218	219	225	228[a]
60% point, °C	222	231	223[b]	225	224	235	230	224	226	233	235[a]
70% point, °C	229	239	230[b]	231	231	240	237	230	231	238	240[a]
80% point, °C	234	247	235[b]	237	236	244	242	237	235	255	244[a]
90% point, °C	239	255	240[b]	243	240	258	247	244	239	272	258[a]
95% point, °C	247	262	248[b]	250	251	269	256	249	247	286	269[a]
Residue, wt. % (D2887)	0	0	--	0.5	0	0	0	0	0	0	--

[a] calculated
[b] extrapolated from measured values

variables that were likely candidates were paraffin/aromatic ratio, olefin content, presence of light ends, presence of heavy ends, and cetane number. It should be noted that the descriptions of the fuels that follow were prepared throughout the project and not at the project initiation.

Procurement of various additives was of major concern. It was felt that refinery products were both cost-effective and representative of compounds which were present in various fuels. On the other hand, many refinery packages contain a large number of various compounds, and it would be difficult to pinpoint the effects of individual compounds. It was decided to use both refinery packages, where applicable, and pure compounds from chemical supply firms in other cases. A source of refinery specialty products was obtained from Dr. George P. Gross of Exxon Research and Engineering Company. Dr. Gross and others discussed fuel effects at the 1979 Detroit SAE meeting. His responding letter and attachment describing specialty products available from Exxon are included in Appendix B, pages B-3 through B-5. Follow-up material concerning Exxon specialty products along with other refiner products are also located in Appendix B, pages B-6 through B-13.

The aromatic content was studied using two approaches. The first additive source was an Exxon specialty product (Exxon "HAN"), which contains 88 percent "heavy aromatics". The product was chosen because it was derived from a refinery stream. The second additive source was originally to be a normal alkylbenzene aromatic package. The only packages that were offered consisted of normal alkylbenzene aromatics whose total carbon numbers were between C_{17} and C_{21}, which boil higher than the base fuel. A mono-aromatic package with a boiling range similar to the base fuel was formulated using individual compounds available from various suppliers.

The boiling point distribution of the base fuel, SwRI code EM-395-F, was plotted to determine the distribution of individual compounds by overlaying a step function representing the individual compounds such that the fuel curve bisects each step. This procedure enabled the pure aromatic fuel blend to exhibit a boiling point curve similar to that of the base fuel. Figure 1 illustrates this method. Criteria for individual compound selection were availability, boiling point, and cost. The large step that occurred in the middle of the boiling range was due to the unavailability of a mono-aromatic compound. A di-aromatic compound, napthalene, boiling at 218°C, would have smoothed the step function, but it was considered important to use only mono-aromatics in this blend. The pure mono-aromatic package consisted of the compounds listed in Table 3.

The fuel blend containing the Exxon "HAN" was prepared by blending enough Exxon "HAN" into 25 liters of base fuel, EM-395-F, to raise the aromatic content to approximately 30 percent. The "HAN" fuel blend was coded EM-434-F. Similarly, the pure mono-aromatic package was used with an additional 25 liters of base fuel to raise its aromatic content to about 30 percent. The mono-aromatic blend was coded EM-460-F. The properties of each fuel blend are listed in Table 2.

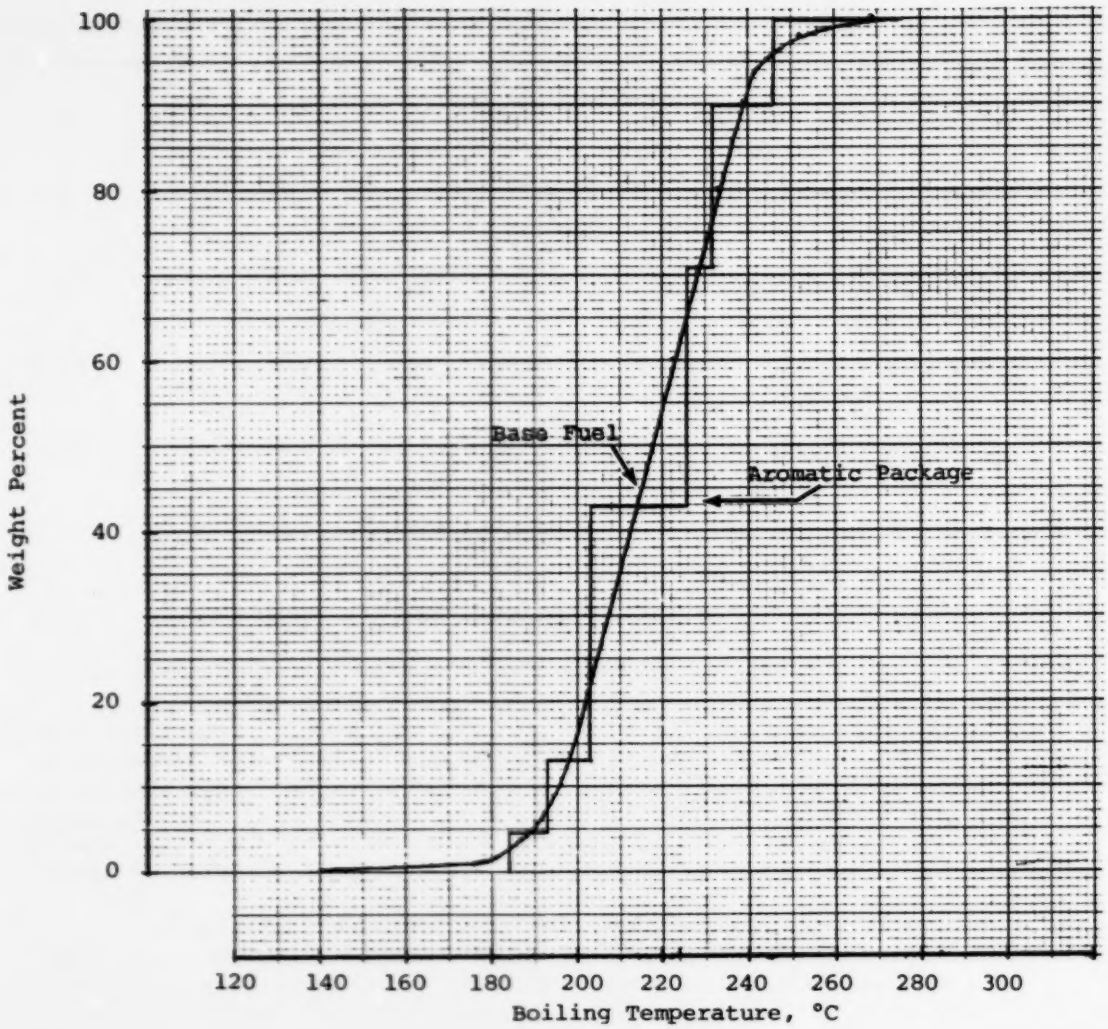
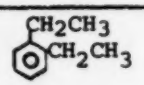
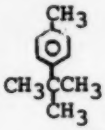
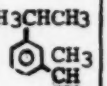
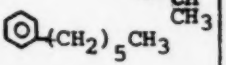
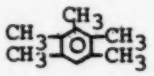
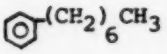
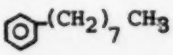


Figure 1. Determination of the Pure Aromatic Compound Distribution

TABLE 3. PURE MONO-AROMATIC PACKAGE COMPOSITION

Compound	Structure	Boiling Point, °C	Percent in Pkg.
diethylbenzene, m-,o-,p-	o- 	184	3.0
4-tert-butyltoluene		193	9.5
diisopropylbenzene,m-,o-,p-	m- 	203	31.5
n-hexylbenzene		226	28.0
pentamethylbenzene		232	17.0
n-heptylbenzene		246	9.0
n-octylbenzene		265	2.0

The effects of olefin content in the fuel were studied using a pure alpha olefin package, purchased from Chevron. The carbon number range for this package was C_{11} to C_{14}, and it had a boiling range between 198 and 257°C. Enough of this package was blended with base fuel to raise the olefin content from 1.5 to approximately 6.5 percent. This olefin fuel blend was coded EM-438-F, and its properties are listed in Table 2.

Investigation of suitable additives to study light and heavy ends, i.e., expanding the boiling point distribution of the base fuel towards lower boiling points and then higher points, was somewhat difficult. It was originally intended to use refinery cuts of materials boiling just below and just above the initial and end point temperatures of the base fuel, EM-395-F. Possible candidates for the presence of low ends included cuts from a JP-4 or typical unleaded gasoline. A high-end cut of unleaded gasoline seemed to be the best candidate. The presence of heavy ends was to be accomplished similarly by using a low-end cut of a No. 6D boiler fuel or addition of "cat-cracker-gas" (gas oil).

A problem developed when the proposed blends were reviewed. If the blends at the target boiling point distribution were made using refinery

products, then the boiling range of the blends would be similar to some of the fuels previously examined during prior EPA Contract No. 68-30-2440.[6] Since the base fuel, EM-395-F, had a very narrow boiling range, it would not be possible to extend the boiling range beyond the fuels previously tested without creating an essentially new fuel.

Base fuel EM-395-F had a boiling point range that was overlapped by fuels studied under the previous contract.[6] By using either refinery paraffin packages or mixtures of pure paraffins representative of what may constitute the low and high ends, the effects were investigated without duplicating fuels previously tested. The addition of paraffins was such as to represent a smooth increase (for low ends) or decrease (for high ends) of the individual compound concentrations in order to represent a refinery cut distribution. The target range for low-end addition was 30 percent by weight boiling under 200°C, and for the high-end addition, 30 percent by weight boiling over 240°C, both by ASTM-D2887.

It was hoped that pure paraffin packages in the appropriate boiling ranges could be obtained from refineries. An investigation revealed that many specialty products, including mixtures of pure compounds in the same class, were no longer available. The few that were available would not create a boiling curve as smooth as desired. An alternative was to use a mixture of pure paraffins whose combined boiling points would simulate the boiling range desired. It was planned to prepare an additive package from pure compounds that were probably present in the refinery stream, with concentrations that would cause the initial boiling and end points of the base fuel to increase or decrease logarithmically.

An Exxon essay report[8] discussing the properties of Prudhoe Bay Alaskan crude was obtained from Norm Sefer of SwRI's Division 05. An analysis of a crude cut, between 100 and 150°C, was used as a guideline to determine candidate compounds and the distribution of paraffins, isoparaffins, and naphthenes. This table is located in Appendix B, page B-14. Several of the compounds were chosen for use, and were to be blended such that the ratio of paraffins, isoparaffins and naphthenes were similar to the Prudhoe Bay distribution. Unfortunately, this approach could not be used due to unavailability of several compounds from suppliers, or their extremely high cost. It was decided to use compounds that were readily available at a reasonable cost, and which had the desired boiling points. An attempt was made to prepare blends such that they contained paraffins, isoparaffins, and naphthenes.

The pure compounds available for the heavy-end paraffin additive package are shown in Table 4. Isoparaffins in the desired boiling range were not commercially available. The target range was to extend the heavy end to 30 percent boiling over 240°C. The concentration of the additive package required was determined by calculating the quantity of this package (boiling over 240°C) needed to reduce the base fuel's weight percent distilled from 90 percent to 70 percent at 240°C. The following calculation took into account weight percent contributions from both the additive package and the base fuel. Thus, the heavy-end extended blend

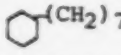
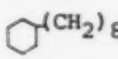
$$\begin{pmatrix}\%\text{ additive}\\ \text{over } 240°C\end{pmatrix}\begin{pmatrix}\text{fraction}\\ \text{additive}\\ \text{in mix}\end{pmatrix} + \begin{pmatrix}\%\text{ fuel}\\ \text{over } 240°C\end{pmatrix}\begin{pmatrix}\text{fraction}\\ \text{fuel}\\ \text{in mix}\end{pmatrix} = \begin{pmatrix}\%\text{ mix}\\ \text{over } 240°C\end{pmatrix}$$

$$\text{or} \quad 100\%\,(A) + 10\%\,(1-A) = 30\%$$

$$A = 0.22$$

was mixed at 78 percent base fuel and 22 percent paraffin compounds boiling over 240°C.

TABLE 4. HEAVY-END PARAFFIN ADDITIVE COMPOSITION

Compound	Structure	Boiling Point, °C	Percent in Pkg.
n-tetradecane	$CH_3(CH_2)_{12}CH_3$	254	31.8
n-octylcyclohexane		264	18.2
n-pentadecane	$CH_3(CH_2)_{13}CH_3$	270	13.6
nonylcyclohexane		282	12.7
n-hexadecane	$CH_3(CH_2)_{14}CH_3$	286	12.3
n-heptadecane	$CH_3(CH_2)_{15}CH_3$	302	11.4

Since the additive package did not boil under 254°C, several points for the blended fuel's curve were calculated by using 78 percent of the base fuel's weight percent values under 254°C. A curve was then drawn through the calculated points up to 254°C. The curve was extended logarithmically to 100 percent to represent the desired high-end distribution. A step function characteristic of the mixture of pure compounds was drawn on the curve such that each step was bisected by the curve. This procedure is illustrated in Figure 2, The percent of each pure compound required was determined by measuring the height of each step, and dividing by the total percent of the entire paraffin package. For example, n-octylcyclohexane boils at 264°C. The height of the step at 240°C is 4 percent (see Figure 2). Since the entire paraffin package constitutes 22 percent of the blend, the percent of n-octylcyclohexane in the package is 18.2 percent (4/22 x 100). The heavy-end blend was coded EM-461-F, and its properties are listed in Table 2.

A similar procedure was used to determine the light-end addition using the pure compounds listed in Table 5. At the proposed light-end range of 30 percent boiling under 200°C, all the additives would have

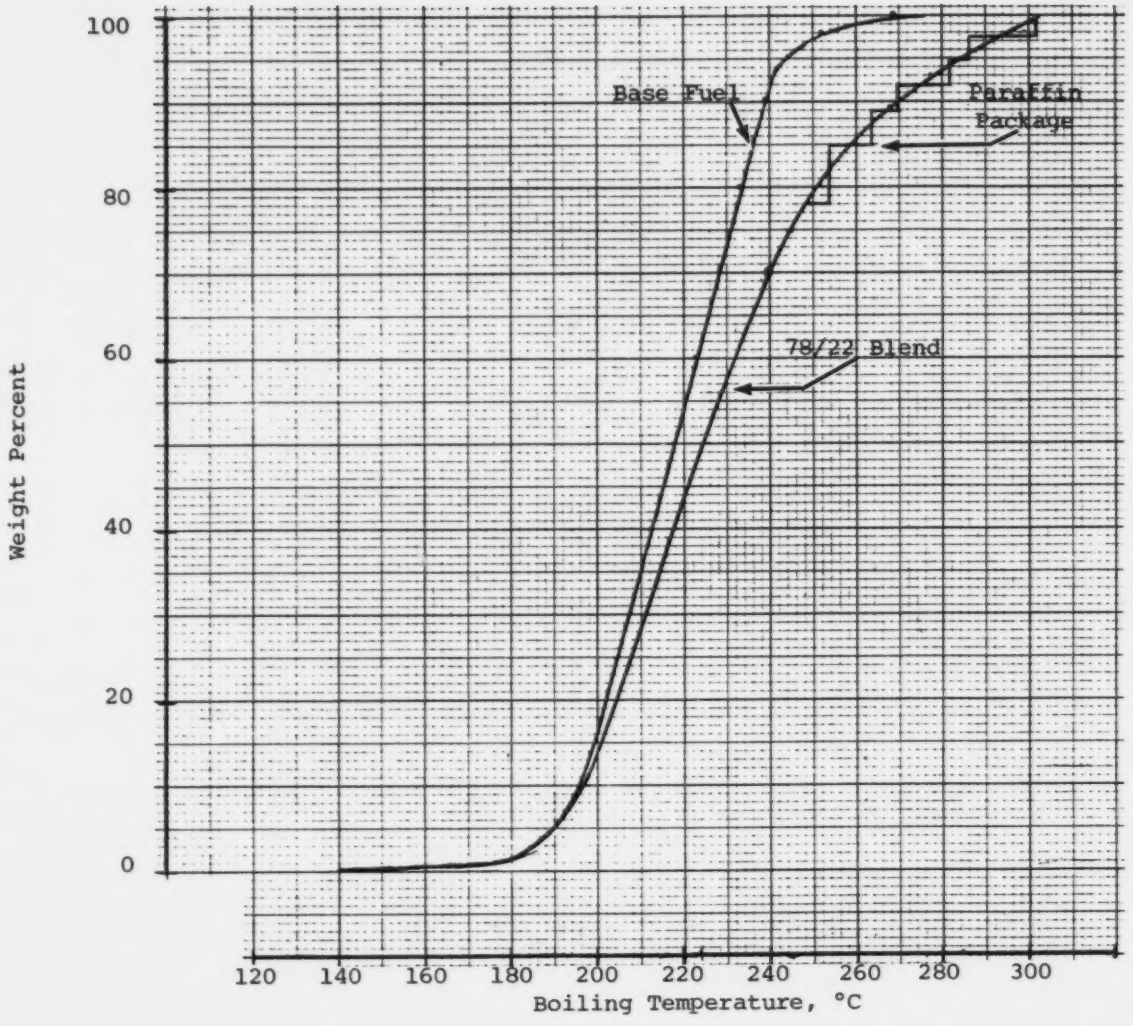
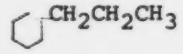
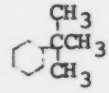
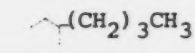


Figure 2. Determination of the Individual Heavy Paraffin Compound Distribution

TABLE 5. ORIGINAL LIGHT-END PARAFFIN ADDITIVE PACKAGE COMPOSITION

Compound	Structure	Boiling Point, °C	Percent in Package
2,2 dimethylheptane	$CH_3C(CH_3)_2(CH_2)_4CH_3$	133	4.7
4-methyloctane	$CH_3(CH_2)_2CH(CH_3)(CH_2)_3CH_3$	143	8.2
n-nonane	$CH_3(CH_2)_7CH_3$	151	10.6
n-propylcyclohexane		157	16.5
3-methylnonane	$CH_3CH_2CH(CH_3)(CH_2)_5CH_2$	167	9.4
tert-butylcyclohexane		167	9.4
n-decane	$CH_3(CH_2)_8CH_3$	174	17.6
n-butylcyclohexane		180	23.5

vaporized. The equation used to determine the ratio of additive to base fuel is shown below:

$$\begin{pmatrix}\%\text{ additive}\\ \text{under 200°C}\end{pmatrix}\begin{pmatrix}\text{fraction}\\ \text{additive}\\ \text{in mix}\end{pmatrix} + \begin{pmatrix}\%\text{ fuel}\\ \text{under 200°C}\end{pmatrix}\begin{pmatrix}\text{fraction}\\ \text{fuel}\\ \text{in mix}\end{pmatrix} = \begin{pmatrix}\%\text{ mix}\\ \text{under 200°C}\end{pmatrix}$$

$$\text{or} \quad 100\%\ (A) + 16\%\ (1\text{-}A) = 30\%$$

$$A = 0.17$$

The ratio of the light-end extended blend would be 83 percent base fuel and 17 percent pure compounds. The fuel curve and additive step function are shown in Figure 3.

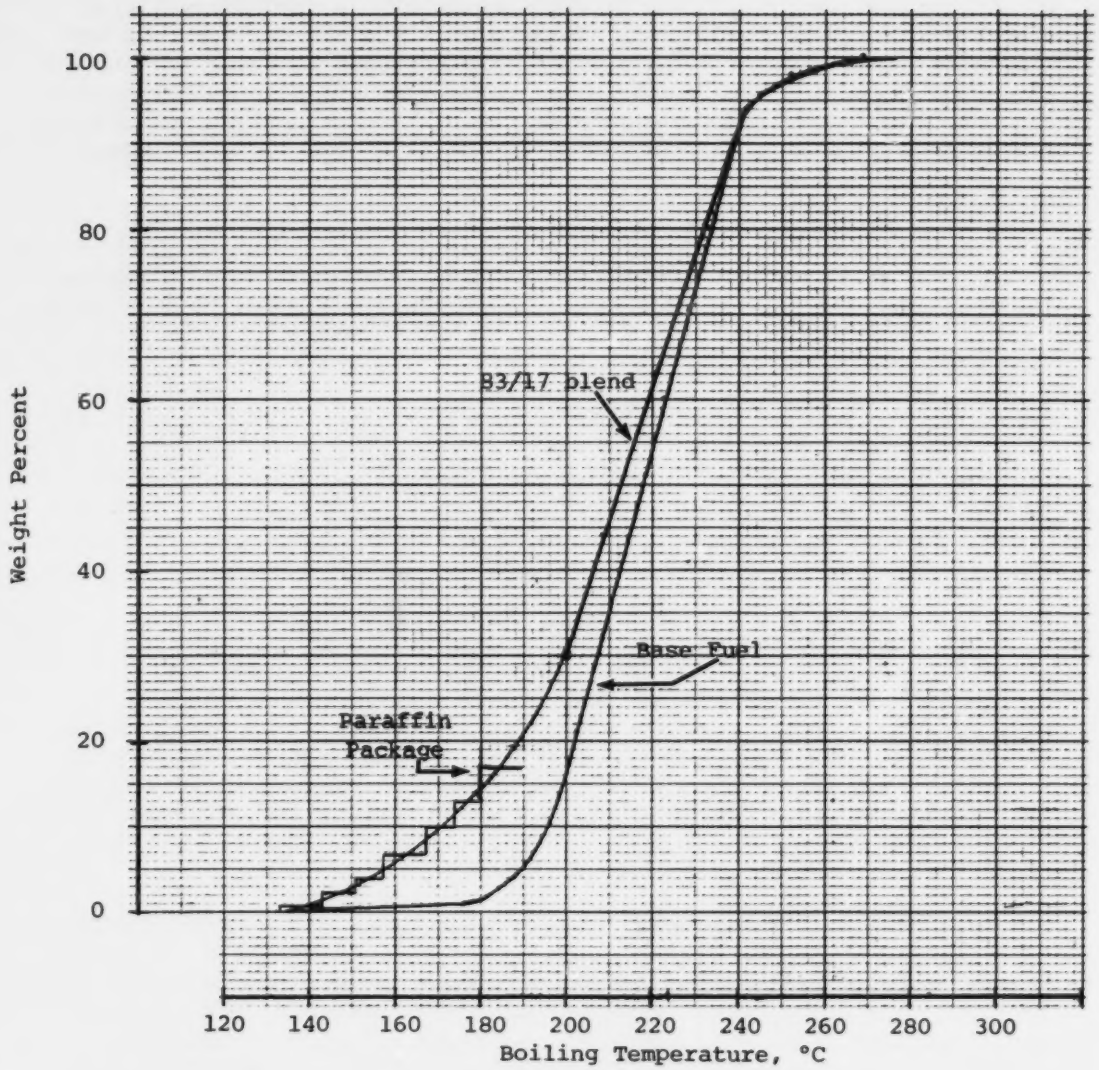


Figure 3. Determination of the Individual Light Paraffin Compound Distribution

A problem developed when attempting to purchase the compounds in Table 5. Some compounds originally available from suppliers were discontinued. The cost of pure compounds is generally high, but several of the chosen compounds were prohibitive. An alternate approach adopted was to replace several of the pure compounds with a readily available isoparaffin package from Exxon. This specialty product, Isopar G, had a boiling range between 157 and 176°C (see Appendix B, pages B-7 and B-8 for specifications). To complete the smooth boiling point distribution, n-nonane and 4-methyloctane were also used. The actual light-end package composition used is listed in Table 6. The light-end blend was coded

TABLE 6. FINAL LIGHT-END PARAFFIN PACKAGE COMPOSITION

Compound	Structure	Boiling Point, °C	Percent in Package
Isopar G	mixed isoparaffins	157-176	15.2
n-nonane	$CH_3(CH_2)_7CH_3$	151	4.4
4-methyloctane	$CH_3(CH_2)_2\overset{CH_3}{\overset{\vert}{C}}H(CH_2)_3CH_3$	143	1.0

EM-448-F, and its properties are listed in Table 2.

The effect of cetane number was studied by using a commercially available cetane improver. The cetane improver was essentially ethyl hexyl nitrate. When the Exxon "HAN" heavy aromatics were added to the base fuel to create fuel blend EM-434-F, the cetane number dropped from 61 (EM-395-F, base fuel) to 44 (EM-434-F). Enough cetane improver was added to EM-434-F to bring the cetane number up to 60. This new fuel blend was coded EM-463-F. It was hoped that this blend would help separate the effects of aromatic content and cetane number. The fuel properties of EM-463-F are given in Table 2.

Comparing the eleven test fuels to each other shows that relatively large ranges of properties are present, as shown in Table 7. These ranges are expressed as percentages above and below property values for the base fuel coded EM-395-F. For calculation purposes, the nitrogen concentration of the base fuel was assigned a value of 1 ppm. The properties were varied so as to be most orthogonal to each other, and in most cases this goal was accomplished.

TABLE 7. RANGES IN PROPERTIES OF TEST FUELS

Property	Range in Test Fuels, %[a]
Density, g/mℓ	+4.2, -1.3
Cetane Number (D613)	+10.2, -28.3
Paraffins, vol. %	+2.9, -29.2
Olefins, vol. %	+340., -33.3
Aromatics, vol. %	+450., -53.4
IBP, °K[b] (D2887)	+1.1, -2.7
50% point, °K	+2.1, -1.5
EP, °K	+8.0, -0.7
Carbon, wt. %	+1.8, -0.1
Hydrogen, wt. %	+0, -10.8
Nitrogen, wt. %	+93000., -0
Gum, mg/100 mℓ	+7100., -0

[a] expressed as percentages above and below properties of EM-395-F

IV. INSTRUMENT AND ANALYTICAL PROCEDURES

Exhaust emissions were measured and samples collected applying procedures set forth in the Federal Register[1], earlier EPA contracts[2,3 4,5], and those developed for use during this project. This section describes the equipment and procedures used to evaluate fuel effects on gaseous and particulate exhaust emissions.

A. Vehicle Operation and Smoke Measurements

The Mercedes 240D was operated to simulate road experience on a 2-roll Model ECE-50 Clayton light-duty chassis dynamometer, of the type qualified for Federal light-duty certification.[9] Inertia and power absorption settings used for all test work on this dynamometer followed EPA guidelines.[9]

Exhaust smoke measurements were made using an optical light-extinction smokemeter, of the type specified in Federal regulations for heavy-duty diesel engine smoke certification.[10] The smokemeter was mounted on a 51 mm (2 in.) O.D. tailpipe extension when in use. The control/readout unit for the smokemeter was mounted remote from the vehicle under test, and continuous recordings of smoke opacity were made concurrently with vehicle speed traces. Smoke measurements were made over the first 505 seconds of the cold-start FTP cycle, while the vehicle was operated on the chassis dynamometer. This procedure was developed for research purposes on an earlier EPA Contract, No. 68-03-2417.[11]

B. Regulated and Unregulated Gaseous Emissions Measurements

Regulated gaseous emissions of hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NO_x) were collected and analyzed using procedures and equipment described in the Federal Register.[9] The method of hydrocarbon analysis was an updated version of that proposed, and eventually adopted, for the 1980 Federal Register.[12] The method of hydrocarbon analysis is shown schematically in Figure 4, and the components are described in Table 8.

The unregulated gaseous emissions measured were aldehydes, phenols, odor, and eight individual hydrocarbons. Aldehydes were measured using the 2,4-dinitrophenylhydrazine (DNPH) method.[2] The method consists of withdrawing a continuous sample of dilute exhaust at a rate of 0.24 m^3/h, and bubbling the sample through glass impingers containing DNPH in hydrochloric acid. This process forms the aldehydes' phenylhydrazone derivatives, which are eventually injected into a gas chromatograph equipped with a flame ionization detector, for separation and identification.

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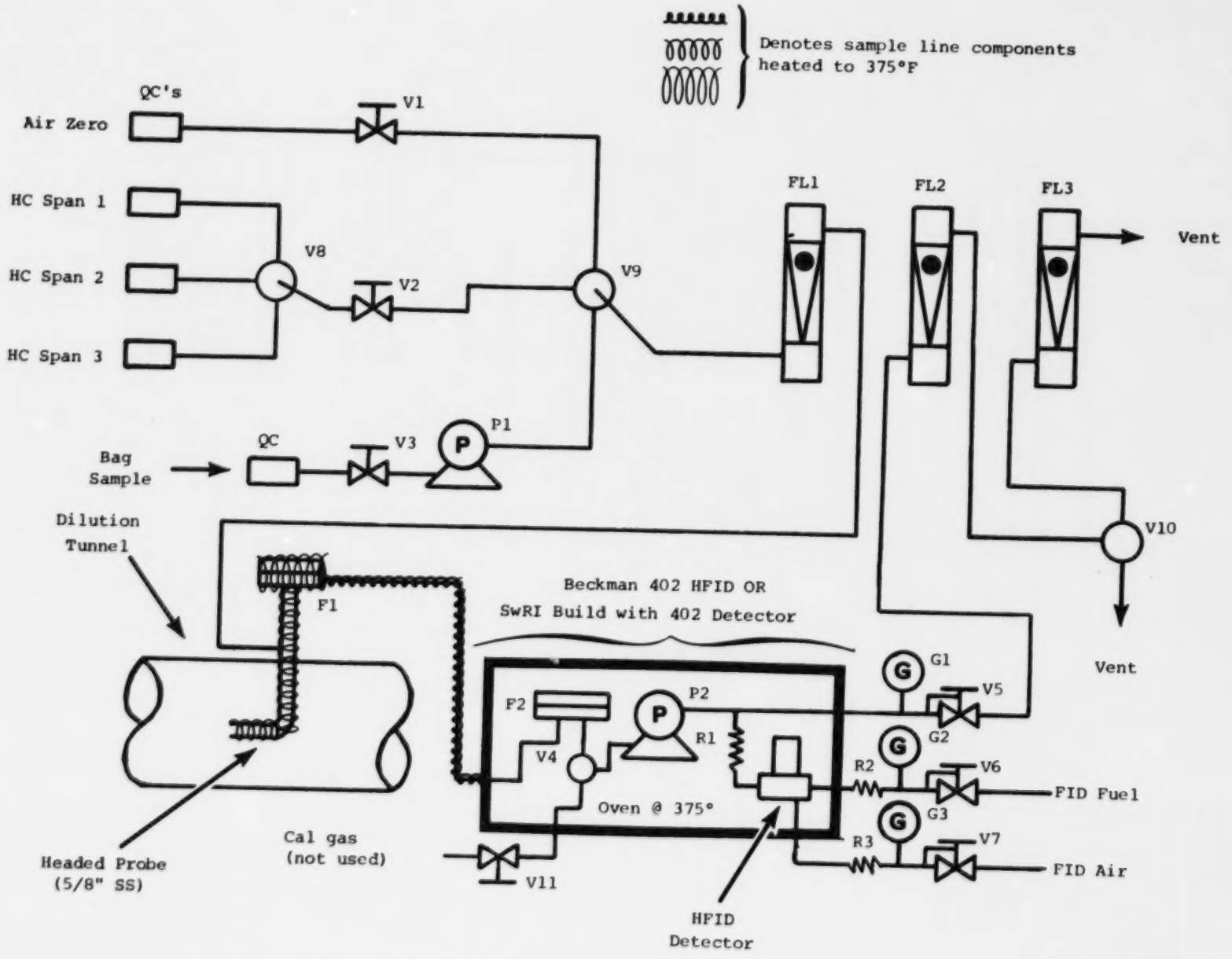

Figure 4. Heated hydrocarbon analyzer system.

TABLE 8. HEATED HYDROCARBON ANALYZER OVERFLOW CALIBRATION AND SAMPLE FLOW SCHEMATIC COMPONENT DESCRIPTION

Component	Designation	Description of Function
Valve	V1	regulating valve for zero air
Valve	V2	regulating valve for HC span gas
Valve	V3	regulating valve for bag sample
Valve	V4	span/zero selector valve in HFID (not used)
Valve	V5	sample backpressure regulator
Valve	V6	FID fuel pressure regulator
Valve	V7	FID air pressure regulator
Valve	V8	HC span selector valve
Valve	V9	HC span/zero/bag sample selector valve
Valve	V10	leak check flow diverter valve
Restrictor	R1	sample capillary
Restrictor	R2	FID fuel restrictor
Restrictor	R3	FID air restrictor
Gage	G1	sample backpressure gage
Gage	G2	FID fuel pressure gage
Gage	G3	FID air pressure gage
Filter	F1	heated 7.0 cm filter (probe)
Filter	F2	heated 7.0 cm filter (oven)
Pump	P1	bag sample pump
Pump	P2	FID heated sample pump
Flowmeter	FL1	overflow flowmeter
Flowmeter	FL2	FID bypass flowmeter
Flowmeter	FL3	leak check flowmeter

The term "individual hydrocarbons" is used to denote the collection and analysis of the following compounds: methane, ethane, ethylene, acetylene, propane, propylene, benzene, and toluene. The individual hydrocarbon (IHC) procedure[2] consists of collecting a dilute sample in a Tedlar (DuPont Co.) bag, and injecting a sample from the bag into a four-column gas chromatograph for separation and identification. Samples for IHC were withdrawn from the same bags used to collect dilute exhaust samples for measurement of regulated emissions.

Phenols were measured using the ether extraction procedure.[2] The first step was to collect dilute exhaust in impingers containing aqueous potassium hydroxide, at a rate of 1.02 m^3/hr. The contents of the impingers are acidified and extracted with ethyl ether, and are eventually injected into a gas chromatograph equipped with a flame ionization detector. At the time of project initiation, the phenol sample filtering requirements had yet to be finalized. Phenol samples were therefore collected from both filtered and unfiltered dilute exhaust.

Exhaust odor was evaluated by incorporating the A. D. Little "Diesel Odorant Analytical System" (DOAS). The procedure used in this study varied from the normal procedure[13] in two ways. First, the vehicle was operated on a transient cycle rather than at steady-state. Second, the exhaust sample taken was dilute rather than raw. The principal reasons for adopting the two modifications were to make optimum use of test cycle and test time. The sample system is shown schematically in Figure 5. Sample flowrate through the Chromosorb 102 traps was 0.43 m^3/hr. Taking into account sampling time during the cycle and dilution ratio of the exhaust, the average amount of undiluted exhaust collected was 36 liters. This volume is within the requirements of the normal procedure.[13] The LCO (liquid column oxygenate) and LCA (liquid column aromatic) results were corrected to undiluted exhaust values by applying the dilution factor. This correction was performed such that the TIA (total intensity of aroma) values could be compared to existing data bases throughout the literature. The TIA values are defined by either TIA = 1 + $\log_{10}$ (LCO, µg/ℓ) or TIA = 0.4 + 0.7 $\log_{10}$ (LCA, µg/ℓ), whichever generates the highest value.

C. Particulate Mass Rate, Concentration, and Aerodynamic Sizing

Particulate collection for this project was performed using a 457 mm (18 inch) diameter by 5 m (16 feet) long dilution tunnel operating on total vehicle exhaust. Other associated equipment included probes, pumps, and filter holders to withdraw and collect the particulate on filters, and a balance to determine the mass of particulate collected.

The dilution tunnel is similar to that used in a previous study[6], but modified by installing an additional 114 mm (4.5 inch) probe at the downstream end of the tunnel. This large probe was used to withdraw a dilute exhaust sample at a rate of 3.4 m^3/hr (120 SCFM) through a 500 x 500 mm (20x20 inch) Pallflex filter (Pall Corporation). The dilution

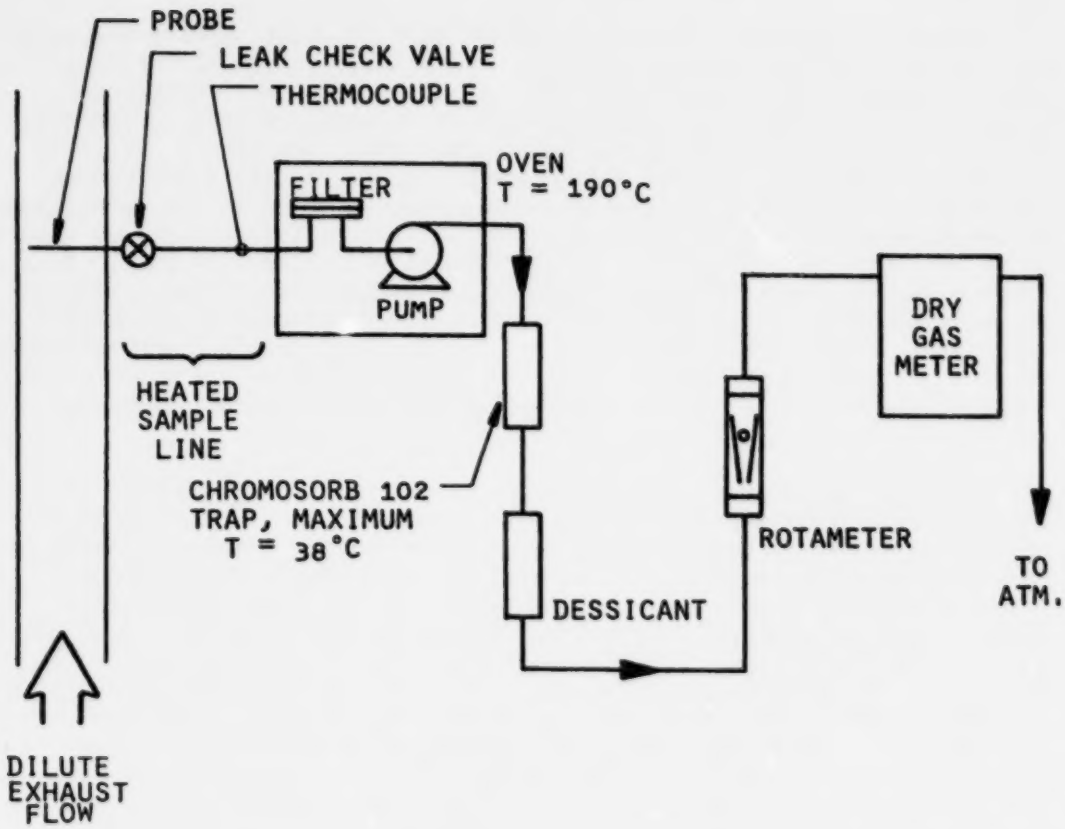

Figure 5. Schematic diagram of DOAS sampling system.

tunnel used is shown schematically in Figure 6. Some of the equipment necessary for collecting particulate and relating it to undiluted vehicle emissions is not shown in the schematic. It includes a constant volume sampler (CVS) operating at a nominal capacity of 12.6 m^3/hr (450 CFM) to withdraw and measure unsampled air/exhaust mixture, and the positive-displacement pump (capacity 3.4 m^3/hr) used for the 500 x 500 mm filter system.

Figures 7, 8, and 9 show the dilution tunnel as set up with the vehicle. The vehicle's exhaust entered the tunnel horizontally near the upstream end, and sampling took place near the downstream end. Four probes and holders used to collect particulate on 47 mm filters are shown protruding from the top of the tunnel in Figure 8. The lines from the holders lead to pumps, flowmeters, and dry gas meters to control flowrate and record sample volumes. At the end of the tunnel, the 114 mm probe led to a filter holder capable of securing a 500 x 500 mm filter, heat exchanger, adjustable valve for flow control, and a 3.4 m^3/hr positive displacement pump. Constant flowrate was accomplished by maintaining temperature and pressure constant at the pump inlet. It should be noted that the net flowrate through the tunnel was affected considerably by the presence of the 500 x 500 mm sample system. Figure 9 shows the 500 x 500 mm filter holder at the right of the tunnel. Figure 10 also shows placement of the 500 x 500 mm filter into its holder.

Particle sizing was accomplished using a radial-slot impactor. The impactor system contained stainless steel stages on which particulate matter was supposedly fractionated by size, and a final Pallflex backup filter. The impactor was located at the downstream end of the dilution tunnel. Figure 9 shows the impactor system protruding on the left side of the tunnel. Figure 11 shows the impactor system disassembled with the stages, plates, and filter removed from their holder for clarity. In operation, each stage was placed on a plate such that the slots in each stage decreased in width from sample entrance down to the filter. Each stage was rotated 45 degrees so the particulate matter passing through the slots impacted on a solid portion of the following stage. Particle retention characteristics were related to the slot size and flowrate through the impactor. The flowrate was controlled using a metal bellows vacuum pump, pressure gauge, and flowmeter. The flowrate was maintained at 0.47 ℓ/min (0.1 CFM) to achieve particle sizing down to 0.1 micron.

The mass of particulate matter collected on sample filters and impactor discs was determined on a microbalance. This balance is enclosed in a vibration-resistant, temperature- and humidity-controlled chamber to minimize outside interferences. Filters and other materials for weighing were allowed to stabilize in the chamber for a minimum of 12 hours before they were weighed. The sensitivity of the balance is 1 μg. Air to the chamber flows at about 17 m^3/hr on a one-pass basis, and keeps the chamber pressure at about 2.5 kPa above atmospheric. The control system

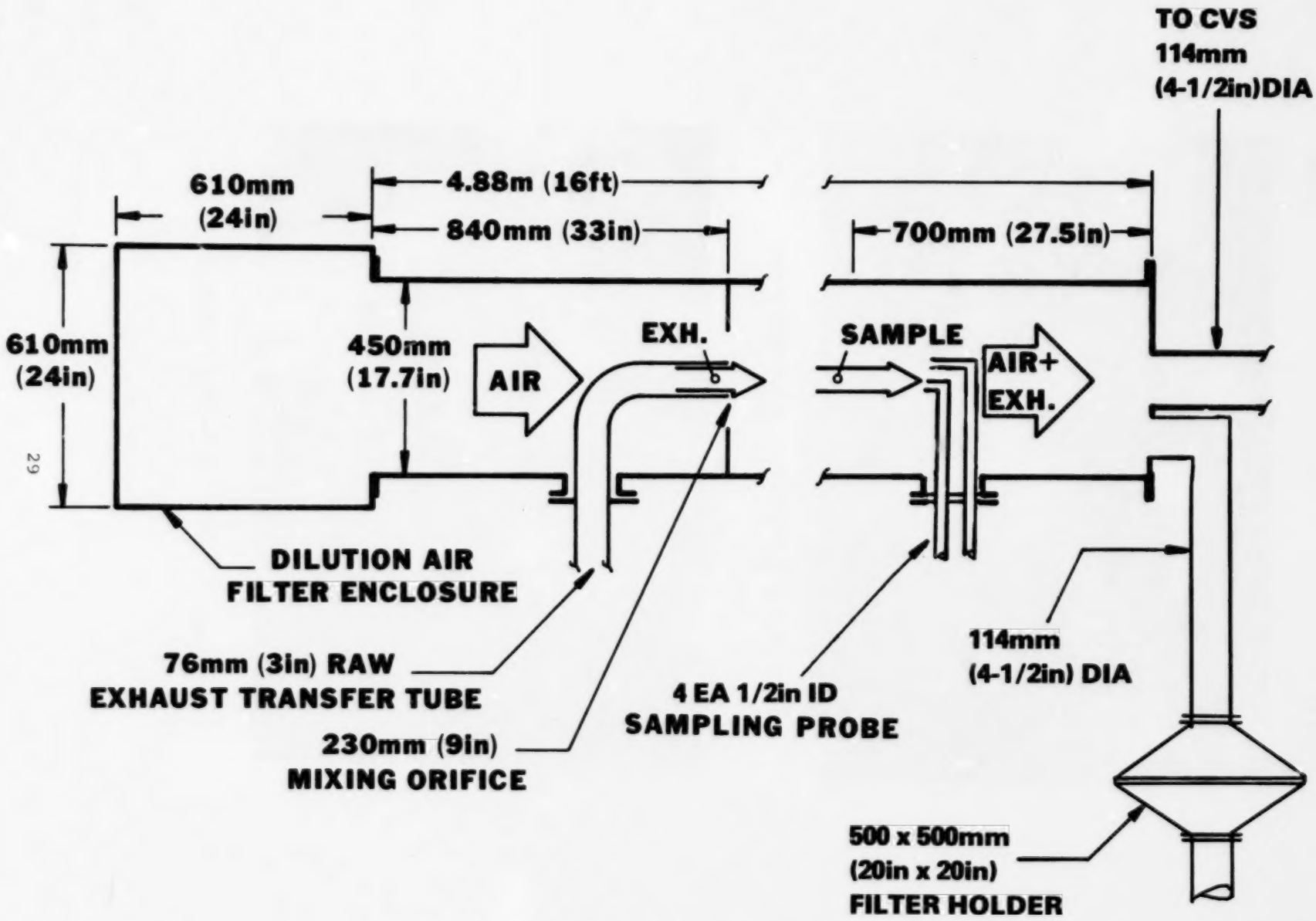

Figure 6. Schematic diagram of exhaust dilution tunnel.

Figure 7. Mercedes 240D during test.

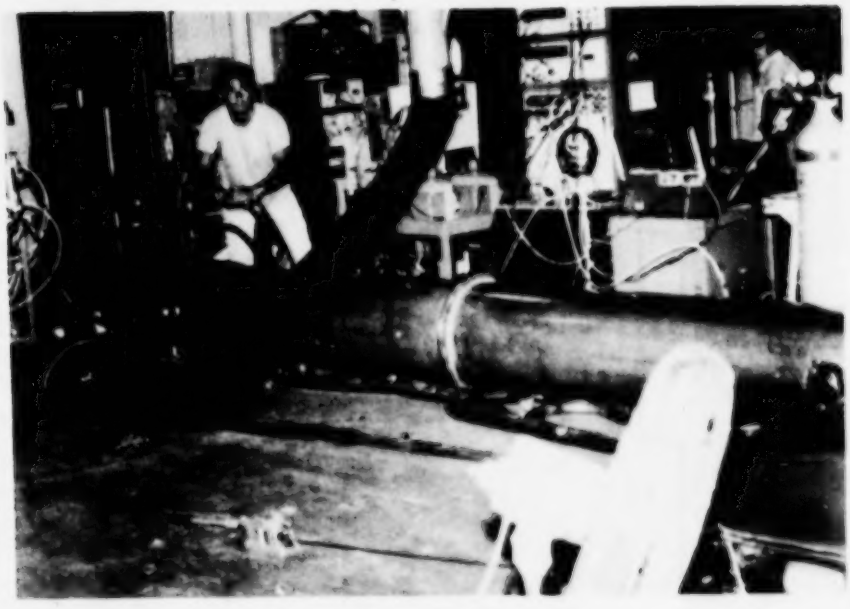

Figure 8. Dilution tunnel configuration.

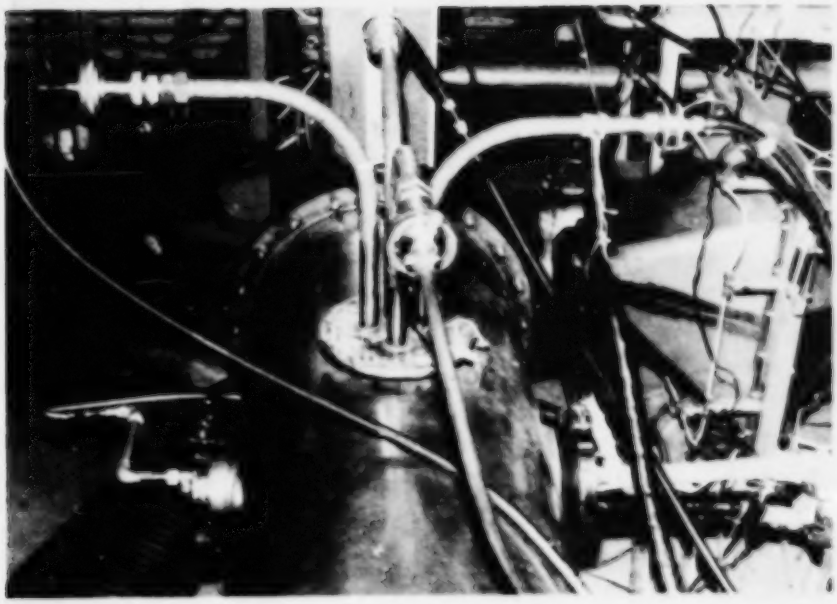

Figure 9. Location of particulate sampling probes on tunnel.

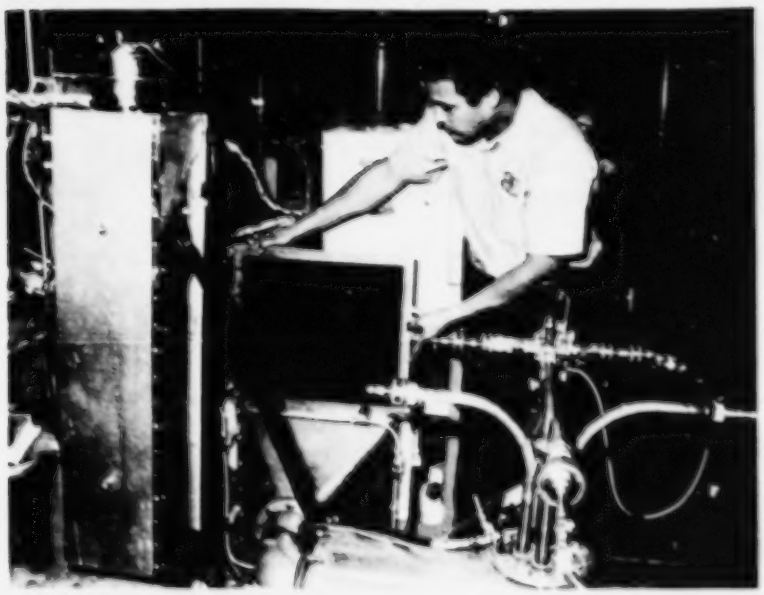

Figure 10. Loading of 20x20 filter into holder.

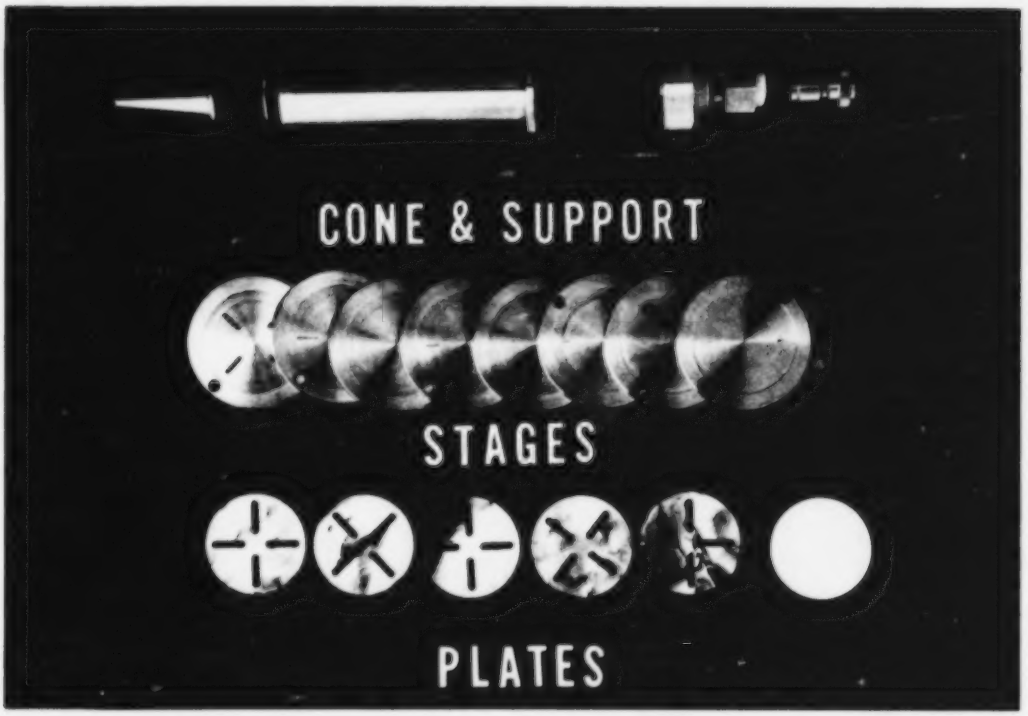

Figure 11. Particle sizing impactor dissassembled.

keeps chamber conditions at 22.2 ± 0.6°C and 63 ± 2 percent relative humidity, and air entering the chamber is filtered through a 99.99 percent DOP-efficient filter.

D. Analysis of Particulate Composition

Particulate samples were acquired by several methods for various analyses. After determining particulate matter weights, the samples were subjected to analysis for major elements and trace elements. Some particulate samples were collected in order to obtain the soluble fraction of particulate matter. Analysis of the soluble fraction is discussed in the next section.

1. Trace Elements

Analysis for trace elements (metals and sulfur) in the particulate matter was performed on 47 mm Fluoropore filter samples. As provided in the contract agreement, these determinations were made at EPA's Research Triangle Park laboratories as part of the EPA in-house measurement program. The instrumentation used for these analysis was a Siemens MRS-3 x-ray fluorescence spectrometer.

2. Major Elements

Samples collected on 47 mm glass fiber filters were sent to Galbraith Laboratories and analyzed for carbon, hydrogen, and nitrogen content by combustion and subsequent gas analysis. The equipment used was a Perkin-Elmer Model 240B automated thermal conductivity CHN analyzer. Results of this analysis were reported in percent of submitted mass and weight of element detected on the filter. These results make the filter weighing accuracy very important.

Oxygen analysis was available from Galbraith using the same instrumentation described above. Samples collected on glass fiber filters could not be used, since glass fiber contains oxygen. Fluoropore filters were unacceptable collection media, because fluorine present in fluoropore causes interference. Silver membrane filters were used to collect particulate matter for oxygen analysis. This medium was not used for carbon, hydrogen, and nitrogen analysis because of the uncertainty of success. In both cases, blank filters were submitted to permit blank corrections.

E. Analysis of the Soluble Fraction of Particulate Matter

The soluble fraction of particulate matter was obtained by extraction from the 500 x 500 mm (20x20 inch) Pallflex filters. This large filter enabled enough soluble material to be extracted so that the total amount could be divided into smaller aliquots, then analyzed for a variety of constituents.

1. Total Soluble Organics

The 500 x 500 mm filters were weighed before and after test to determine the weight of particulate matter. Each filter was extracted using methylene chloride in a Soxhlet apparatus. The solvent volume was reduced at low temperature and under vacuum. The remaining solvent/solubles were transferred to a preweighed container, and the solvent was evaporated by nitrogen purging. The total mass of solubles was determined gravimetrically, and the percent of solubles in the particulate matter calculated.

2. Major Elements

One aliquot of the dried, weighed soluble extract was submitted to Galbraith Laboratories and analyzed for carbon, hydrogen, oxygen, and sulfur by the technique and instrumentation described in Section IV, D. 2 (Perkin-Elmer 240B). An additional aliquot of soluble extract was submitted to SwRI's Mobile Energy Division for nitrogen analysis by oxidative pyrolysis and chemiluminescence.

3. Solubles Boiling Range and Individual n-Paraffin Analysis

Another aliquot of soluble extract was submitted to SwRI's Mobile Energy Division for determination of the boiling range and reference to normal paraffins. The procedure is a high-temperature variation of ASTM D2887-73. Each aliquot was dissolved in carbon disulfide, and an internal standard (C_9 and C_{11} compound) was added for quantitative results. The maximum temperature that this column reached was 450°C, eluting compounds boiling up to 650°C.

4. Benzo(a)pyrene (BaP) and Ames Bioassay

An additional 500 x 500 mm (20x20 inch) filter was extracted, and the extract was divided into eleven aliquots. One aliquot was used to determine the BaP content of the soluble extract. This analysis was performed by SwRI's Department of Emissions Research. The procedure, developed by others[14], is based on high-performance liquid chromatography to separate BaP from other organic solubles in particulate matter; and it incorporated fluorescence detection to measure BaP. The instrument used was a Perkin-Elmer 3B liquid chromatograph equipped with a MPF-44 fluorescence spectrophotometer. Excitation was at a wavelength of 383 nm, and emission was read at 430 nm. The remaining ten aliquots were shipped on dry ice to EG&G for Ames bioassay testing.

V. TEST PLAN, OPERATING SCHEDULE AND DATA REDUCTION

The following sections describe the test plan, sequence, and schedule. Procedures used for data reduction to meet the requirements of the scope of work are also outlined.

A. Test Plan

The major problem to overcome in structuring this project was to evaluate as many emissions as possible during vehicle operation. Developing a test plan on this basis allowed a large amount of information to be collected with a minimum repetitive testing effort, and enabled a variety of test fuels to be evaluated. An outline of exhaust constituents analyzed and their corresponding methods is presented in Table 9.

The vehicle followed the "4-bag" FTP[9] cycle during most sample collection and measurement runs, except those for smoke. Smoke evaluations were performed separately during the cold transient portion of the FTP (first 505 seconds). The cold transient portion incorporates all of the most interesting modes from a smoke standpoint, including engine start, first idle, first acceleration, second idle, and second acceleration. FTP cycle description is well documented in other works.[5,6,9] An 85 km/h cruise condition was periodically used on a few of the more "interesting" fuels. This cruise condition was originally used in a previous study[6], and was carried over into this study for continuity. Ideally, a 20-minute continuous cruise was to be run. However, due to temperature requirements of the filter sample, the cruise schedule was divided into two ten-minute periods. A description of the 85 km/h cruise procedure is located in Appendix C, page C-2.

The test plan incorporating the cycles and evaluations for each test fuel is shown in Table 10. Most samples were taken over each 2-bag FTP, defined as a "cold FTP" or a "hot FTP". Testing for each fuel required three days. After the first day of testing, the results were reviewed to determine whether or not replicate analysis would be required on the second day of testing. It was important to determine the validity of the test as early as possible to avoid costly reruns and depletion of limited quantities of test fuel to repurge the fuel system. Duplicate filter samples were collected on Day 2, and retained for possible replicate analyses.

Utilizing this test plan on eleven test fuels yielded a total of 45 runs, including baseline repeats and additional runs to replace erroneous data or supply missing information. The first three digits of the test number are the same as the fuel code, and the remaining letters and digits relate to run numbers. For example, test 395-A,1 means testing of fuel EM-395-F; "A" represents analyses of day 1; and "1" is the run number.

TABLE 9. OUTLINE OF CHEMICAL AND PHYSICAL EXHAUST EVALUATIONS

Exhaust component under study	Constituent (s) analyzed for	Collection Method	Analysis technique(s)
smoke	smoke (visible)	----	EPA smokemeter (continuous)
gases	HC, CO, CO_2, NO_x	sample bag	constant volume sampler
	aldehydes	wet impinger	DNPH
	individual hydrocarbons	sample bag	injection, GC
	odor	DOAS traps	DOAS analyzer
	phenols	wet impinger[a]	extraction, GC
particulate	total mass	Pallflex filters	gravimetric
	size distribution	impactor-filter	gravimetric
	sulfur & trace elements	filter, 47 mm Fluoropore	x-ray fluorescence
	carbon, hydrogen in particulate	filter, 47 mm glass filter	combustion (commercial)
	oxygen in particulate	47 mm silver filter	combustion (commercial)
	organic extractable substances	"20x20" filter	soxhlet extraction
	BaP in organic solubles	----	LC, fluorescence detection
	molecular weight range of organic solubles	----	GC
	carbon, hydrogen, sulfur, oxygen in solubles	----	combustion (commercial)
	nitrogen in solubles	----	oxidation pyrolysis
	biological response of solubles	----	Ames bioassay

[a]two sets of samples before and after filtration

TABLE 10. TEST PLAN FOR EACH FUEL

	Day 1 (A)		Day 2 (B)[a]			Day 3 (C)
Analysis or Sample	Cold FTP	Hot FTP	Cold FTP	Hot FTP	85 km/h[b]	cold transient (505 seconds)
gaseous HC, CO, NO_x, CO_2	X	X	X	X	X	-
aldehydes	X	X	-	-	X	-
individual hydrocarbons	X[c]	-	-	-	X	-
phenols	X	X	-	-	X	-
odor	← X[d] →		----------		-	-
total part. mass	X	X	X	X	X	-
size distribution	← X[d] →		----------		-	-
sulfur & trace metals	X	X	X	X	X	-
C, H, N in part.	X	X	X	X	X	-
oxygen in part.	X	X	X	X	X	-
organic extractables	X	X	-	-	X	-
BaP and Ames bioassay	-	-	X	X	-	-
smoke	-	-	-	-	-	X

[a] repeat samples optional
[b] run occasionally
[c] uses first bag (505) of gaseous HC, CO, NO_x, CO_2 collection
[d] one sample collected for entire 4-bag FTP

At the Project Officer's request, the technical direction of this project was altered somewhat to permit acquisition of extra samples for nitroaromatic analysis by Battelle (via HERL-EMSL contract). These extra fuels and samples were run in lieu of other possible candidate fuel blends that might have been tested under the scope of the fuel variable study.

B. Data Reduction

Most data reduction was straightforward and required no special efforts. Calculations for regulated gaseous emissions were performed using computer programs which employed computational methods given in Emissions Certification Regulations for light-duty diesel vehicles.[9] The computer programs were fully documented in a previous report.[6] An example of a computer printout is located in Appendix C, Page C-3.

Particulate mass rate and concentration calculations followed the guidelines given in the Federal Register.[1] The particulate rate for record was based on collection by 47 mm Pallflex filters. The particulate mass rate was also calculated on the basis of collection by the large "20x20" Pallflex filters, other 47 mm filter media, and the impactor system. These calculations were performed for comparison purposes.

The unregulated emission calculations were performed by applying previously-derived formulae, recorded supplementary data, and conversion factors to the results generated by the analytical procedures.[2] Many small calculator programs were written to streamline data reduction into units most widely accepted (e.g., mass/distance, percent, etc.). A copy of the principal calculator program and data reduction form are located in Appendix C, pages C-4 through C-7.

VI. GASEOUS EMISSION AND ODOR RESULTS

This report section includes presentation and discussion of results on regulated gaseous emissions, aldehydes, individual hydrocarbons (IHC), phenols, and exhaust odor. Replicate regulated gaseous and total particulate emissions varied approximately 6 percent from initial run values. Where applicable, minimum detection limits (in mass/distance) were calculated to place results in perspective. The minimum detection limits were calculated on the basis of analytical (concentration) minimum detection limits, total dilute sample volume and distance traveled over the cycle.

A. Regulated Gaseous Emission Results

Data on regulated gaseous emissions, including CO_2 and fuel consumption, were obtained by analysis of bag samples collected from the CVS-diluted exhaust. These results are summarized in Table 11. The results are reported for each individual bag, a calculated 3-bag FTP, and a calculated 4-bag FTP. The computer printouts for each test are located in Appendix D, pages D-2 through D-35.

Regulated gaseous emissions from the Mercedes 240D test vehicle are quite low, and most of the trends weak. The highest hydrocarbon and CO values appeared for the pure aromatic and cetane-improved aromatic blends (EM-460-F and EM-463-F). Fuel blend EM-463-F also exhibited the highest NO_x emissions.

B. Individual Hydrocarbon Results

Individual hydrocarbon (IHC) results are presented in Table 12. The minimum detection limit for the IHC's was 0.85 mg/km. It appeared that the "heavy aromatic" blend (EM-434-F) was associated with a reduction in these specific hydrocarbons, most notably ethane. This result is surprising when compared to the results of the other fuel blends containing aromatics (EM-460-F and EM-463-F). These latter aromatic blends were associated with increases in all individual hydrocarbons as compared with the base fuel, EM-395-F.

C. Aldehyde Results

Concentrations of a number of individual low-molecular weight aldehydes were determined in CVS-diluted exhaust. The results for each aldehyde species and their sums are presented in Table 13. It should be noted that "acetone" includes acrolein and propanol, and that the isobutyraldehyde values were attributed to a column artifact. The

TABLE 11. REGULATED GASEOUS EMISSIONS DATA

Fuel	Item	Emissions (g/km) and fuel usage (ℓ/100 km) by Driving Schedule						
		FTP Bag Number				(Calculated)	(Calculated)	Steady-State
		1	2	3	4	3-bag FTP	4-bag FTP	85 km/h
EM-395-F	HC	0.10	0.10	0.09	0.10	0.09	0.10	0.10
	CO	0.51	0.56	0.45	0.56	0.52	0.52	0.40
base	CO_2	254.9	239.2	220.6	231.8	237.3	235.1	184.6
	NO_x	0.74	0.78	0.70	0.76	0.75	0.74	0.72
	Fuel	10.26	9.52	8.76	9.37	9.46	9.42	7.72
EM-404-F	HC	0.08	0.08	0.07	0.09	0.08	0.08	---
	CO	0.47	0.49	0.42	0.51	0.47	0.48	---
+ iso.	CO_2	256.0	231.9	22.14	232.9	234.0	234.3	---
	NO_x	0.75	0.78	0.72	0.80	0.76	0.76	---
	Fuel	10.39	9.41	8.98	9.45	9.50	9.61	---
EM-405-F	HC	0.09	0.08	0.08	0.09	0.08	0.09	0.08
	CO	0.47	0.48	0.41	0.50	0.46	0.47	0.30
++ iso.	CO_2	260.8	233.8	224.3	227.4	236.7	234.9	188.0
	NO_x	0.91	0.91	0.86	0.88	0.89	0.88	0.74
	Fuel	10.56	9.47	8.95	9.22	9.59	9.51	7.61
EM-430-F	HC	0.09	0.09	0.08	0.11	0.09	0.09	---
	CO	0.52	0.55	0.46	0.56	0.52	0.52	---
shale	CO_2	255.3	246.2	229.8	241.7	243.7	242.3	---
	NO_x	0.82	0.87	0.79	0.83	0.84	0.83	---
	Fuel	10.22	9.86	9.20	9.69	9.76	9.70	---
EM-434-F	HC	0.12	0.13	0.10	0.14	0.12	0.12	0.08
	CO	0.55	0.65	0.50	0.67	0.59	0.60	0.44
heavy	CO_2	259.6	254.4	226.3	248.7	247.7	246.1	197.5
aro.	NO_x	0.85	0.93	0.82	0.92	0.88	0.88	0.85
	Fuel	9.97	9.78	8.69	9.56	9.52	9.45	7.58
EM-438-F	HC	0.09	0.09	0.08	0.10	0.09	0.09	---
	CO	0.47	0.52	0.43	0.54	0.48	0.49	---
olefins	CO_2	260.9	241.0	225.0	233.0	240.8	238.4	---
	NO_x	0.83	0.88	0.80	0.87	0.85	0.85	---
	Fuel	10.66	9.86	9.20	9.54	9.84	9.75	---
EM-448-F	HC	0.11	0.12	0.10	0.12	0.11	0.11	---
	CO	0.48	0.51	0.43	0.54	0.48	0.49	---
light end	CO_2	248.4	232.1	216.7	228.2	231.3	230.1	---
	NO_x	0.82	0.84	0.78	0.81	0.82	0.81	---
	Fuel	10.22	9.55	8.91	9.39	9.51	9.46	---
EM-401-F	HC	0.11	0.12	0.09	0.13	0.11	0.11	0.09
	CO	0.49	0.53	0.45	0.57	0.50	0.51	0.34
alt. base	CO_2	258.7	238.3	226.1	239.9	239.2	239.6	192.2
	NO_x	0.86	0.86	0.80	0.84	0.85	0.84	0.84
	Fuel	10.32	9.51	9.02	9.58	9.55	9.57	7.67
EM-460-F	HC	0.14	0.13	0.10	0.14	0.13	0.13	---
	CO	0.57	0.67	0.49	0.64	0.60	0.59	---
pure aro.	CO_2	259.4	248.0	229.6	231.2	245.3	240.3	---
	NO_x	0.94	0.93	0.89	0.91	0.92	0.91	---
	Fuel	10.11	9.67	8.94	9.02	9.56	9.37	---
EM-461-F	HC	0.09	0.09	0.07	0.08	0.08	0.08	---
	CO	0.47	0.50	0.42	0.50	0.47	0.48	---
heavy end	CO_2	256.1	236.1	222.8	227.6	236.6	234.1	---
	NO_x	0.83	0.89	0.81	0.89	0.86	0.86	---
	Fuel	10.42	9.62	9.07	9.27	9.63	9.53	---
EM-395-F	HC	0.10	0.09	0.08	0.11	0.09	0.09	0.09
	CO	0.53	0.58	0.47	0.58	0.54	0.54	0.38
base	CO_2	252.6	243.9	223.5	226.8	235.1	232.9	194.3
	NO_x	0.82	0.82	0.81	0.84	0.82	0.82	0.72
	Fuel	10.27	9.52	9.08	9.22	9.55	9.47	7.89
EM-463-F	HC	0.13	0.14	0.10	0.14	0.13	0.13	---
	CO	0.63	0.73	0.56	0.74	0.66	0.67	---
+ cetane	CO_2	266.2	250.6	235.8	245.5	249.7	248.2	---
improver	NO_x	1.05	1.06	1.03	1.07	1.04	1.05	---
	Fuel	10.25	9.66	9.08	9.47	9.62	9.57	---

TABLE 12. INDIVIDUAL HYDROCARBON EMISSIONS

Fuel Code	Individual Hydrocarbons,[a] mg/km							
	Methane	Ethane	Ethylene	Acetylene	Propane	Propylene	Benzene	Toluene
EM-395-F	6.17	16.77	0.65	4.50	0.00	4.49	3.66	0.00
EM-404-F	5.06	14.89	0.34	3.27	0.00	3.84	3.42	0.00
EM-405-F	8.56	18.36	0.35	3.19	0.00	4.10	2.74	1.23
EM-430-F	--	--	--	--	--	--	--	--
EM-434-F	0.00	5.81	0.23	1.50	0.34	0.32	0.00	0.00
EM-438-F	7.71	16.58	0.00	4.62	0.00	4.31	0.30	0.00
EM-448-F	6.36	15.38	0.00	3.71	0.00	4.93	1.05	0.00
EM-401-F	7.26	17.62	1.18	4.24	0.00	4.97	2.11	0.00
EM-460-F	0.00	21.38	0.94	5.31	0.00	5.87	4.85	0.00
EM-461-F	0.00	11.16	0.00	0.00	0.00	5.64	0.00	0.00
EM-395-F	8.00	19.84	1.25	4.34	0.00	4.67	0.00	0.00
EM-463-F	8.00	21.51	0.70	3.51	0.00	6.75	0.00	4.01

[a]Detected in the first 505 seconds of a cold FTP

TABLE 13. ALDEHYDE AND PHENOL EMISSIONS DATA

Fuel Type	H 320 BASE STOCK				395-F + isoquinoline ~ 0.04 % N			395-F + isoquinoline ~ 0.1 % N			
Fuel Code, EM -	395-F				404-F			405-F			
Cycle	Cold FTP	Hot FTP	Calculated 1981 FTP	85 km/h	Cold FTP	Hot FTP	Calculated 1981 FTP	Cold FTP	Hot FTP	Calculated 1981 FTP	85 km/h
Aldehydes, mg/km											
Formaldehyde	1.19	0.00	0.51	0.22	0.00	0.06	0.03	22.33	0.09	9.66	0.24
Acetaldehyde	0.24	0.00	0.10	0.00	0.02	0.00	0.00	11.27	0.19	4.90	0.00
Acetone[a]	0.00	0.00	0.00	3.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Isobutyraldehyde	9.84[b]	11.22[b]	10.63[b]	0.14[b]	9.35[b]	21.49[b]	16.27[b]	6.70[b]	6.20[b]	6.42[b]	0.00
Crontonaldehyde	0.00	0.00	0.00	0.00	0.00	0.20	0.12	0.00	0.00	0.00	0.00
Hexanaldehyde	0.00	0.00	0.00	0.01	0.08	0.40	0.27	1.19	0.17	0.61	0.15
Benzaldehyde	--	--	--	--	--	--	--	--	--	--	--
"Total"[c]	1.43	0.00	0.61	3.80	0.10	0.66	0.31	34.79	0.45	15.22	0.39
Phenols, mg/km											
Filtered Samples											
Phenol	0.46	0.00	0.20	0.00	1.41	0.00	0.61	5.90	0.00	2.56	0.00
Salicylaldehyde	0.84	0.00	0.36	4.38	2.69	2.16	2.39	23.66	2.00	11.31	0.13
m-Cresol+p-Cresol	0.00	0.00	0.02	0.00	0.33	0.16	0.23	2.10	0.00	0.90	0.00
Group Five[d]	0.31	0.00	0.13	3.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,3,5-trimethylphenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.82	0.00	1.64	0.00
2,3,5,6-tetramethylphenol	0.00	0.00	0.00	0.00	0.00	0.54	0.31	22.43	0.00	9.64	0.00
2-n-propylphenol	0.00	1.10	0.63	0.00	0.73	0.84	0.79	6.69	0.87	3.37	0.06
"Total"	1.67	1.10	1.34	7.75	5.16	3.70	4.33	64.60	2.87	29.40	0.19
Unfiltered Samples											
Phenol	0.04	0.25	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Salicylaldehyde	0.00	0.00	0.00	0.00	0.01	0.89	0.51	0.19	0.62	0.44	0.00
m-Cresol+p-Cresol	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Group Five[d]	0.04	0.16	0.11	0.00	0.62	0.00	0.27	0.00	0.00	0.00	0.00
2,3,5-trimethylphenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,3,5,6-tetramethylphenol	0.00	0.00	0.00	0.00	0.19	0.00	0.08	8.85	0.27	3.96	0.09
2-n-propylphenol	0.03	0.34	0.20	0.00	0.00	1.49	0.85	0.22	0.00	0.09	0.08
"Total"	0.12	0.75	0.47	0.00	0.82	2.38	1.71	9.26	0.89	4.49	0.17

[a] Includes acrolein and propanol

[b] Artifact

[c] Does not include isobutyraldehyde and crontanaldehyde

[d] Group five consists of p-ethylphenol, 2-isopropylphenol, 2,3,-xylenol, 3,5-xylenol, 2,4,6-trimethylphenol

TABLE 13 (Cont'd). ALDEHYDE AND PHENOL EMISSION DATA

Fuel Type	395-F + Shale Oil Cut ~0.05%N			395-F +Exxon "HAN", 30% Aromatic				395-F + olefin pkg., ~7% olefins		
Fuel Code, EM -	430-F			434-F				438-F		
Cycle	Cold FTP	Hot FTP	Calculated 1981 FTP	Cold FTP	Hot FTP	Calculated 1981 FTP	85 km/h	Cold FTP	Hot FTP	Test FTP
Aldehydes, mg/km										
Formaldehyde	0.00	0.00	0.00	2.08	3.34	2.80	--	0.00	0.00	0.00
Acetaldehyde	0.00	0.00	0.00	0.00	0.00	0.00	--	0.00	0.00	0.00
Acetone[a]	0.00	0.00	0.00	0.00	0.00	0.00	--	0.00	0.00	0.00
Isobutyraldehyde	12.68[b]	13.78[b]	13.31[b]	0.00	0.00	0.00	--	0.00	0.00	0.00
Crotonaldehyde	0.00	6.07	3.46	0.00	0.00	0.00	--	0.00	0.00	0.00
Hexanaldehyde	0.00	0.00	0.00	0.00	0.00	0.00	--	0.00	0.00	0.00
Benzaldehyde	--	--	--	--	--	--	--	--	--	--
"Total[c]"	0.00	0.00	0.00	2.08	3.34	2.79	--	0.00	0.00	0.00
Phenols, mg/km Filtered Samples										
Phenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Salicylaldehyde	223.21	37.28	121.53	0.77	0.39	0.55	0.21	0.00	0.00	0.00
m-Cresol+p-Cresol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Group Five[d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.14	0.17
2,3,5-trimethylphenol	0.00	0.00	0.00	0.00	0.08	0.05	0.00	0.00	0.00	0.00
2,3,4,5,-tetramethylphenol	0.00	0.00	0.00	0.00	0.11	0.06	0.05	0.00	0.00	0.00
2-n-propylphenol	12.19	2.08	6.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Total"	235.40	39.36	127.96	0.77	0.58	0.66	0.26	0.30	0.14	0.17
Unfiltered Samples										
Phenol	0.00	0.13	0.08	0.00	0.00	0.00	--	0.00	0.00	0.00
Salicylaldehyde	0.78	0.00	0.34	0.00	0.00	0.00	--	0.00	0.00	0.00
m-Cresol+p-Cresol	0.00	0.00	0.00	0.00	0.00	0.00	--	0.00	0.00	0.00
Group Five[c]	0.00	0.00	0.00	0.03	0.14	0.09	--	0.00	0.00	0.00
2,3,5-trimethylphenol	0.00	0.00	0.00	0.00	0.00	0.00	--	0.00	0.00	0.00
2,3,5,6-tetramethylphenol	0.00	0.00	0.00	0.00	0.22	0.13	--	0.00	0.00	0.00
2-n-propylphenol	12.19	0.00	5.24	0.00	0.00	0.00	--	0.00	0.00	0.00
"Total"	12.97	0.13	5.66	0.03	0.36	0.22	--	0.00	0.00	0.00

[a] Includes acrolein and propanol

[b] Artifact

[c] Does not include isobutyraldehyde and crontanaldehyde

[d] Group five consists of p-ethylphenol, 2-isopropylphenol, 2,3-xylenol, 3,5-xylenol, 2,4,6-trimethylphenol

TABLE 13 (Cont'd). ALDEHYDE AND PHENOL EMISSIONS DATA

Fuel Type	395-F + light ends			JP-7				395-F + 30% pure aromatics		
Fuel Code, EM-	448-F			401-F				460-F		
Cycle	Cold FTP	Hot FTP	Calculated 1981 FTP	Cold FTP	Hot FTP	Calculated 1981 FTP	85 km/h	Cold FTP	Hot FTP	Calculated 1981 FTP
Aldehydes, mg/km										
Formaldehyde	7.66	2.76	4.87	3.27	4.71	4.09	3.57	0.00	0.00	0.00
Acetaldehyde	0.97	5.07	3.31	0.00	1.41	0.80	0.46	0.00	0.00	0.00
Acetone[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.83	0.00	0.00	0.00
Isobutyraldehyde	0.00	0.89	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Crotonaldehyde	0.00	0.17	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hexanaldehyde	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzaldehyde	--	--	--	--	--	--	--	--	--	--
"Total[c]"	8.63	7.83	8.18	3.27	6.12	4.89	4.86	0.00	0.00	0.00
Phenols, mg/km Filtered Samples										
Phenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Salicylaldehyde	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.11
m-Cresol+p-Cresol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Group Five[d]	0.00	0.36	0.21	0.00	0.00	0.00	Trace	0.00	0.08	0.05
2,3,5-trimethylphenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,3,5,6-tetramethylphenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02	1.20	1.14
2-n-propylphenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Total"	0.00	0.36	0.21	0.00	0.00	0.00	Trace	1.02	1.48	1.30
Unfiltered Samples										
Phenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Salicylaldehyde	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
m-Cresol+p-Cresol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Group Five[d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,3,5 -trimethylphenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,3,5,6-tetramethylphenol	0.00	5.25	2.99	1.13	0.00	0.49	0.00	0.28	0.56	0.44
2-n-propylphenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Total"	0.00	5.25	2.99	1.13	0.00	0.49	0.00	0.28	0.56	0.44

[a] Includes acrolein and propanol

[b] Artifact

[c] Does not include isobutyraldehyde and crotanaldehyde

[d] Group five consists of p-ethylphenol, 2-isopropylphenol, 2,3-xylenol, 3,5-xylenol, 2,4,6-trimethylphenol

TABLE 13 (Cont'd). ALHDEYDE AND PHENOL EMISSIONS DATA

Fuel Type	395-F + heavy ends			M320 Base Stock				434-F + 0.7% DII-3		
Fuel Code, EM-	461-F			395-F				463-F		
Cycle	Cold FTP	Hot FTP	Calculated 1981 FTP	Cold FTP	Hot FTP	Calculated 1981 FTP	85 km/h	Cold FTP	Hot FTP	Calculated 1981 FTP
Aldehydes, mg/km										
Formaldehyde	5.51	7.75	6.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acetaldehyde	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acetone[a]	1.72	2.29	2.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Isobutyraldehyde	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Crotonaldehyde	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hexanaldehyde	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzaldehyde	--	--	--	--	--	--	--	--	--	--
"Total[c]"	7.23	10.04	8.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phenols, mg/km Filtered Samples										
Phenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Salicylaldehyde	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
m-Cresol+p-Cresol	0.00	0.00	0.00	0.00	0.19	0.11	0.00	0.00	0.00	0.00
Group Five[d]	0.33	0.00	0.14	0.00	0.22	0.13	0.00	0.41	0.00	0.18
2,3,5-trimethylphenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,3,5,6-tetramethylphenol	0.95	0.00	0.41	4.18	0.00	1.80	0.00	0.00	0.00	0.00
2-n-propylphenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Total"	1.28	0.00	0.55	4.18	0.41	2.04	0.00	0.41	0.00	0.18
Unfiltered Samples										
Phenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Salicylaldehyde	0.00	0.44	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
m-Cresol+p-Cresol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Group Five[d]	0.00	0.25	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,3,5,-trimethylphenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,3,5,6-tetramethylphenol	8.21	0.00	3.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-n-propylphenol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Total"	8.21	0.69	3.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00

[a] Includes acrolein and propanol

[b] Artifact

[c] Does not include isobutyraldehyde and crontanaldehyde

[d] Group five consists of p-ethylphenol, 2-isopropylphenol, 2,3-xylenol, 3,5-xylenol, 2,4,6-trimethylphenol

minimum detection limit for each of the aldehydes is listed below:

formaldehyde	0.18 mg/km
acetaldehyde	0.25 mg/km
acetone	0.30 mg/km
isobutyraldehyde	0.36 mg/km
crotonaldehyde	0.35 mg/km
hexanaldehyde	0.45 mg/km
benzaldehyde	0.46 mg/km

The minimum detection limit for "total" aldehydes must be determined for each case, by summing limits for individual aldehydes whose concentrations were summed to represent the total.

The aldehyde data are somewhat scattered, with few trends apparant. When aldehydes were detected, they were usually in the form of formaldehyde and/or acetaldehyde. Of some interest are the high formaldehyde and acetaldehyde observed with fuel EM-405-F (base + isoquinoline at 0.1%N) during the cold FTP. Values of this magnitude were not detected on any of the other fuels. During the hot FTP, these aldehyde emissions were absent. One possibility is that during cold start-up, a substantial amount of raw fuel entered the DNPH impingers and reacted in such a way as to create an artifact. Another possibility is that in the cold combustion chamber, isoquinoline, present in the fuel, caused incomplete oxidation of fuel constituents. The light-end and heavy-end blends also exhibited increases in aldehydes.

D. Phenol Results

Phenols as measured in filtered and unfiltered dilute exhaust are presented in Table 13. The phenol species were analyzed for having molecular weights very near each other. Their minimum detection limits therefore are represented by one value, namely 0.10 mg/km. As discussed earlier in the report, filtered and unfiltered samples were collected because procedural qualification was not complete at project initiation.

In most cases, the filtered phenols exhibited higher values than unfiltered phenols. Exactly why this phenomenon occurred remains speculative. One possibility is that phenols were being absorbed by the particulate in the exhaust, and were later released from the trapped particulate on the heated filter. It was not within the scope of this project to investigate this phenomenon.

The most obvious variation in results was the very high (223 mg/km) emission of salicylaldehyde in the cold FTP filtered sample indicated for the shale oil blend, EM-430-F. This value is over 60 times the phenol emissions of the base fuel. The only other pronounced increase in phenols occurred while testing EM-405-F. This blend, containing isoquinoline, exhibited high filtered phenols during the cold FTP, but not the hot FTP. This trend for that fuel also occurred in its aldehyde emissions. The remaining fuels exhibited slight changes from the base fuel, EM-395-F.

E. Results of Odor Analysis

This subsection contains results from instrumental odor evaluations. It should be noted that application of DOAS to dilute exhaust and transient cycles is experimental at this time. Relationships between steady-state operation and transient cycles are not adequately defined. The application of DOAS in the study was to determine trends between test fuels.

A previous study[7] included an attempt to correlate DOAS odor analysis with a trained odor evaluation panel. In that study, five vehicles were operated on 7 steady-state modes sampling raw exhaust for the DOAS instrument and dilute exhaust for the panel. One vehicle was the same Mercedes 240D used in this study. The study indicated that the Mercedes 240D odor intensity was unaffected by speed and load changes. That study[7] also indicated that TIA of 1.5 to 2.5 related somewhat to Turk "D" ratings of "D"-2.0 to "D"-4.5.

The DOAS odor results are presented in Table 14. TIA values calculated from both LCO and LCA concentrations are listed for reference. Odor intensity is represented by the higher TIA value for each fuel. The TIA values (LCO-based) for the base fuel EM-395-F are less than 1.0. The earlier study[7] indicated that a TIA (LCO-based) of less than 1 would be rated by a trained panel at less than "D"-1.0. A perceived odor intensity of "D"-1.0 by the Turk method is considered a light (barely perceptible) odor, and one which to most people would have low objectionability. The test blends therefore resulted in low odor intensity with the possible exceptions of EM-434-F, EM-438-F, and EM-448-F. Even these fuels indicated TIA values that approached the limits of detectability. The base fuel EM-395-F exhibited the lowest odor intensity.

TABLE 14. DOAS ODOR RESULTS

Order of Test	Fuel Code	Fuel Description	LCO, µg/ℓ	LCA, µg/ℓ	TIA	
					LCO	LCA
1	EM-395-F	H320 base fuel	0.02	1.73	0	0.57
2	EM-404-F	395-F + isoquinoline	0.01	2.56	0	0.69
3	EM-405-F	395-F ++ isoquinoline	0.95	6.28	0.98	0.96
4	EM-430-F	395-F + shale oil cut	0.02	1.73	0	0.57
5	EM-434-F	395-F + heavy aromatics	2.02	3.35	1.31	0.77
6	EM-438-F	395-F + olefins	2.84	5.76	1.45	0.93
7	EM-448-F	395-F + light ends	2.23	3.81	1.35	0.81
8	EM-401-F	JP-7	0.00	2.62	0	0.69
9	EM-460-F	395-F + pure aromatics	0.77	5.68	0.89	0.93
10	EM-461-F	395-F + heavy ends	1.23	4.48	1.09	0.86
11	EM-395-F	H320 base fuel	0.37	2.84	0.57	0.72
12	EM-463-F	434-F + cetane improver	1.13	4.40	1.05	0.85

VII. SMOKE AND PARTICULATE EMISSION RESULTS

This section of the report presents summary data and discussion on visible smoke, total particulate mass emissions, particle size distribution, and particulate matter elemental analysis. In addition, it includes information on organic solubles in particulate matter, elemental analysis of the solubles, BaP in solubles, and boiling range of organic solubles by gas chromatograph analysis.

A. Visible Smoke Emissions

Visible smoke was measured using an EPA-type smokemeter over the first 505 seconds (the "cold transient phase") of the FTP. Data, taken on a 2-pen strip chart recorder, consisted of vehicle speed and smoke opacity versus time. The traces, which were analyzed manually, are located in Appendix E, Pages E-2 through E-11. The results are summarized in Table 15.

TABLE 15. SUMMARY OF VISIBLE SMOKE DATA

Condition	Smoke, PHS %, by fuel										
	395	401	404	405	430	434	438	448	460	461	463
Cold start peak	21.7	12.3	31.5	21.2	---	42.8	14.5	26.7	22.4	27.0	17.6
Cold idle O.K. (after start)	6.0	6.1	8.0	6.0	---	6.3	5.5	5.6	6.8	6.2	7.4
1st accel. peak	26.1	18.8	20.8	19.6	---	14.4	16.0	28.9	46.7	29.2	23.8
Idle at 125 sec., O.K.	2.1	1.1	1.0	1.2	---	2.0	1.2	0.7	2.4	2.4	2.6
Accel at 164 sec., peak	5.0	8.8	5.1	6.0	---	9.1	4.8	5.0	12.7	8.9	21.0

The data indicate that some fuel blends increased, and some decreased visible smoke production compared to base fuel. The olefin blend, EM-438-F, exhibited smoke reductions for all five cycle portions analyzed. The greatest smoke increase occurred with EM-434-F, heavy aromatics. It is interesting that with addition of cetane improver to the heavy aromatic blend (EM-463-F) the smoke level was reduced during the cold-start peak to below that of the base fuel, EM-395-F. On the other hand, the cetane-improved blend exhibited the highest smoke levels of all test fuels at the 164 second acceleration.

B. Particulate Mass Emissions and Concentrations

Total particulate emissions were measured by six different filtering systems. Only the 47 mm Pallflex filter was used strictly for particulate mass rate determinations. The remaining five types of filters were used primarily for other analyses. These five types were also used to calculate particulate mass rates for comparison of various filter media on mass results, and where an identical medium was used, to give support. The particulate mass rates determined using the 47 mm Pallflex filters are those which represent rates as prescribed by Federal Procedures.(1)

Particulate mass rates in mg/km are presented in Table 16. These results show that the rates as determined by Fluoropore (Teflon membrane) filters are noticeably lower than those determined by the other filtering systems. This difference reflects the relatively low exhaust particulate collection efficiency of Fluoropore filters. The remaining media tend to exhibit rates in the same "ballpark".

Results in Table 16 indicate that the light-ends fuel blend, EM-448-F, reduced particulate emissions by approximately 14 percent as compared with the base fuel, EM-395-F. The two blends containing aromatics, EM-434-F and EM-460-F, were associated with increases in particulate emissions of about 27 percent. The addition of the cetane improver to EM-434-F (EM-463-F) increased the particulate emissions even more, to about 68 percent over base fuel EM-395-F. It is also of some interest that the heavy-end blend, EM-461-F, apparently did not cause an increase in particulate emissions, as might have been expected.

In order to give another perspective, Tables 17 and 18 present the particulate emissions in units of g/hr and mg/m^3, respectively. These data help to bring out those values that are significant, and to suppress those that indicate very little change. It should be noted that the olefin blend, EM-434-F, did reduce particulate emissions approximately 15 percent. Other than the aromatic blends previously discussed, the remaining fuel blends apparently did not affect the particulate mass emission rate as compared to EM-395-F.

1. Samples Collected for Nitroaromatic Analysis

Gaseous emission results, particulate mass weights, and other information regarding the acquisition of "20x20" filters for nitroaromatic analysis by Battelle (via HERL-EMSL contract) are located in Appendix E, pages E-20 through E-26. Sample treatment and results obtained by Battelle were not intended to be included in this report.

C. Particulate Size Distributions

Data from the impactor runs were analyzed, including individual run and average percentages of particulate mass by stage, and cumulative percentages of particulate by stage. Basic statistics were computed for each data set.

TABLE 16. PARTICULATE MASS EMISSIONS

Sampling Medium	Fuel	Milligrams Particulate per Kilometer			
		Cold FTP	Hot FTP	(Calculated) 1981 FTP	Steady-State 85 km/h
47 mm Pallflex	EM-395-F	174	158	165	100
	EM-404-F	173	153	162	--
	EM-405-F	175	153	162	81
	EM-430-F	206	160	180	--
	EM-434-F	205	218	212	163
	EM-438-F	161	151	155	--
	EM-448-F	155	133	142	--
	EM-401-F	159	144	151	86
	EM-460-F	233	208	219	--
	EM-461-F	172	150	159	--
	EM-395-F	178	175	176	99
	EM-463-F	285	288	287	--
47 mm Glass Fiber	EM-395-F	176	157	165	104
	EM-404-F	173	158	165	--
	EM-405-F	186	165	174	86
	EM-430-F	198	171	182	--
	EM-434-F	--	246	--	152
	EM-438-F	182	146	167	--
	EM-448-F	150	134	143	--
	EM-401-F	180	166	174	90
	EM-460-F	235	226	230	--
	EM-461-F	172	168	170	--
	EM-395-F	171	163	166	109
	EM-463-F	298	301	300	--
47 mm Fluoropore	EM-395-F	124	116	119	71
	EM-404-F	106	79	91	--
	EM-405-F	106	98	101	55
	EM-430-F	--	69	--	--
	EM-434-F	154	154	154	60
	EM-438-F	--	--	--	--
	EM-448-F	--	--	--	--
	EM-401-F	90	87	89	46
	EM-460-F	160	113	133	--
	EM-461-F	109	84	95	--
	EM-395-F	99	86	92	52
	EM-463-F	154	148	151	--

TABLE 16 (CONT'D). PARTICULATE MASS EMISSIONS

Sampling Medium	Fuel	Milligrams Particulate per Kilometer			
		Cold FTP	Hot FTP	(Calculated) 1981 FTP	Steady-State 85 km/h
47 mm Silver	EM-395-F	196	144	167	--
	EM-404-F	--	--	--	--
	EM-405-F	--	--	--	--
	EM-430-F	--	158	--	--
	EM-434-F	222	166	190	157
	EM-438-F	168	140	152	--
	EM-448-F	147	134	140	--
	EM-401-F	181	180	180	101
	EM-460-F	237	206	219	--
	EM-461-F	177	145	159	--
	EM-395-F	176	152	162	105
	EM-463-F	287	278	282	--
Impactor Set	EM-395-F	→		133	97
	EM-404-F	→		148	--
	EM-405-F	→		145	88
	EM-430-F	→		195	--
	EM-434-F	→		129	100
	EM-438-F	→		119	--
	EM-448-F	→		137	--
	EM-401-F	→		137	74
	EM-460-F	→		269	--
	EM-461-F	→		153	--
	EM-395-F	→		185	--
	EM-463-F	→		285	--
20 x 20 Pallflex	EM-395-F	185	166	175	102
	EM-404-F	176	156	164	--
	EM-405-F	182	157	168	98
	EM-430-F	202	185	192	--
	EM-434-F	222	224	223	153
	EM-438-F	166	152	158	--
	EM-448-F	155	139	146	--
	EM-401-F	178	153	164	93
	EM-460-F	242	225	232	--
	EM-461-F	180	157	167	--
	EM-395-F	187	168	176	97
	EM-463-F	295	284	289	--

TABLE 17. TIME-BASED PARTICULATE EMISSIONS[a]

Fuel	Grams Particulate per hour			
	Cold FTP	Hot FTP	(Calculated) 1981 FTP	85 km/h
EM-395-F	5.87	5.17	5.47	9.33
EM-404.F	5.35	4.98	5.14	--
EM-405-F	5.85	5.19	5.47	7.35
EM-430-F	6.63	5.06	5.74	--
EM-434-F	6.79	6.92	6.87	11.07
EM-438-F	4.93	4.40	4.63	--
EM-448-F	4.77	4.14	4.41	--
EM-401-F	5.03	4.38	4.66	6.69
EM-460-F	6.76	6.66	6.70	--
EM-461-F	5.32	4.72	4.98	--
EM-395-F	5.53	5.43	5.47	8.22
EM-463-F	8.86	8.86	8.86	--

[a] based on data from 47 mm Pallflex filter samples

TABLE 18. PARTICULATE CONCENTRATIONS[a]

Fuel	Particulate Concentration in mg/m^3[b]			
	Cold FTP	Hot FTP	(Calculated) 1981 FTP	85 km/h
EM-395-F	58.0	51.8	54.4	57.9
EM-404-F	52.8	50.0	51.2	--
EM-405-F	57.8	52.1	54.5	45.6
EM-430-F	65.5	50.8	57.1	--
EM-434-F	67.1	69.5	68.5	68.7
EM-438-F	48.7	44.2	46.1	--
EM-448-F	47.2	41.6	44.0	--
EM-401-F	49.7	43 9	46.4	41.5
EM-460-F	66.8	66.8	66.8	37.8
EM-461-F	52.6	47.4	49.6	--
EM-395-F	54.7	54.5	54.6	51.0
EM-463-F	87.6	87.6	87.6	--

[a] based on data from 47 mm Pallflex filter samples
[b] at 101.3 kPa and 21°C

One impactor data set was collected per test fuel, with the exception of the base fuel runs. The impactor was run on each of four base fuel runs to evaluate the "new" impactor system and for statistical purposes. Table 19 lists the impactor results for the four base fuel runs and shows the type of repeatability and variability that can be applied to the individual runs on each test.

Table 20 lists the particle size distribution as percent of the total particulate mass for each test, and Figure 12 presents these data graphically. In most cases, the majority of the particulate mass was under 0.08 μm diameter because the backup filter collected the largest percent of the particulate mass. Figure 12 shows that the combined distribution of all test blends is very similar to the base fuel (EM-395-F) four-run average. This observation is interesting in that each fuel blend exhibited a unique particle distribution. Probable cause for this observation is the large variability at each stage, as seen in Table 19. It is interesting to note that although EM-463-F (base + H.A.N. + cetane improver) was associated with higher particulate mass emissions, it generated more small particles than the same fuel without cetane improver (EM-434-F).

Data such as those presented in Table 20 can also be expressed in cumulative mass percent of particulate smaller than stage cutoff diameter, beginning with the filter and working up through the sampler toward larger agglomerate diameters. The table in Appendix E, Page E-12, lists such data and associated statistics. Data presented in this form reflect the total percent particulate collected at and below a particular cutoff diameter.

D. Analysis of Particulate Composition

This subsection includes data on major elements and trace elements. Carbon, hydrogen, and nitrogen analysis was performed on particulate collected using 47 mm glass fiber filters. Oxygen analysis was performed on particulate collected using 47 mm silver membrane filters. Particulate collected on 47 mm Fluoropore filters was analyzed for trace elements.

A summary of the carbon, hydrogen, and nitrogen content of the particulate matter is given in Table 21. The elemental data show fairly high carbon content, indicative of "dry" or soot-like particulate material rather than oily material. Nevertheless, the particulate carbon content did vary among the test blends used. Fuel blend EM-448-F (light ends) exhibited the highest carbon percentage on the cold FTP. This result was unexpected because of the ease with which light paraffins burn. For the most part, the data are scattered, with no clear trends.

A previous study[6] indicated, as does this one, that a large fraction of particulate matter is unaccounted for by the sum of carbon, hydrogen, and nitrogen. A logical element to "look for" was oxygen. At project initiation, it was planned to attempt analysis of particulate matter for oxygen. The method used has been discussed earlier in the report. Oxygen

TABLE 19. BASE FUEL PARTICULATE SIZE DISTRIBUTION DURING A COMBINED COLD AND HOT FTP

Run	Percent of Total Particulate Mass									Vehcile Total Particulate, g[b]
	Stage 3 6.6 µm[a]	Stage 4 4.1 µm	Stage 5 2.6 µm	Stage 6 1.1 µm	Stage 7 0.85 µm	Stage 8 0.54 µm	Stage 9 0.34 µm	Stage 10 0.08 µm	Filter	
1	3.533	1.536	2.304	1.536	4.455	2.611	1.997	4.608	77.419	4.014
2	1.041	3.892	4.801	4.020	2.980	2.724	2.982	3.632	66.151	4.104
3	1.719	3.582	1.289	3.152	4.441	2.865	4.298	7.880	70.774	3.723
4	2.786	2.089	3.203	8.217	4.178	7.382	11.003	10.306	50.836	4.282
Average	2.270	2.775	2.899	4.231	4.014	3.896	5.070	6.607	66.295	4.031
Vmax	3.533	3.892	4.801	8.217	4.455	7.382	11.003	10.306	77.419	4.282
Vmin	1.041	1.536	1.289	1.536	2.980	2.865	1.997	3.632	50.836	3.723
S.D.	1.107	1.141	1.490	2.850	0.701	2.327	4.066	3.063	11.296	0.233
Range	2.492	2.356	3.512	6.681	1.475	4.517	9.006	6.674	26.583	0.559
Vari., %	48.766	41.116	51.377	67.346	17.458	59.727	80.199	46.367	17.039	5.791

[a] effective cutoff diameter
[b] based on 47 mm Pallflex

TABLE 20. PARTICLE SIZE DISTRIBUTION OF PARTICULATE COLLECTED WITH IMPACTOR

Fuel Code EM-	Cycle	Percent of Total Particulate									Vehicle Total Particulate g/cycle[b]
		Stage 3 6.6 µm[a]	Stage 4 4.1 µm	Stage 5 2.6 µm	Stage 6 1.1 µm	Stage 7 0.85 µm	Stage 8 0.54 µm	Stage 9 0.34 µm	Stage 10 0.08 µm	Filter	
395-F	FTP	3.533	1.536	2.304	1.536	4.455	2.611	1.997	4.608	77.419	4.01
395-F	85 km/h	0.204	0.409	2.454	0.204	0.818	0.613	0.818	2.863	84.663	2.79
395-F	85 km/h	0.000	0.000	0.000	0.209	0.418	0.626	0.835	2.923	95.198	2.96
395-F	FTP	1.041	3.892	4.801	4.020	2.980	2.724	2.982	3.632	66.151	4.10
404-F	FTP	0.000	0.000	0.193	0.387	1.161	1.934	2.708	2.515	91.683	3.74
404-F	FTP	0.155	0.000	2.009	0.000	6.646	3.709	1.855	4.791	80.835	4.10
405-F	FTP	0.648	0.324	0.000	4.862	4.862	3.079	1.945	2.755	81.524	4.30
405-F	85 km/h	0.000	0.388	0.581	0.581	1.357	2.326	4.457	0.000	90.310	2.31
430-F	FTP	3.383	3.800	5.283	5.706	6.230	4.861	3.170	4.651	62.942	4.45
434-F	FTP	0.000	1.393	1.084	7.743	0.000	7.592	10.372	12.384	59.443	5.21
438-F	FTP	0.000	2.978	3.762	5.486	4.702	3.135	4.389	5.643	69.906	3.89
448-F	FTP	2.772	1.188	6.535	1.386	5.545	4.356	3.168	8.515	66.535	2.99
401-F	FTP	1.718	0.000	3.626	1.908	2.863	1.527	4.771	6.107	77.481	3.62
401-F	85 km/h	0.000	0.000	0.000	1.734	0.000	4.348	1.449	4.348	88.116	2.22
460-F	FTP	1.252	0.096	1.541	0.385	0.289	4.528	4.624	9.152	77.938	5.21
461-F	FTP	0.000	3.731	2.425	0.933	2.799	1.119	2.799	0.373	85.821	3.82
395-F	FTP	1.719	3.582	1.289	3.152	4.441	2.865	4.298	7.880	70.77	3.72
395-F	FTP	2.786	2.089	3.203	8.217	4.178	7.382	11.003	10.306	50.84	4.28
463-F	FTP	2.041	1.952	1.413	7.064	0.628	1.727	2.512	1.727	80.926	6.76

[a] effective cutoff diameter
[b] based on 47 mm Pallflex

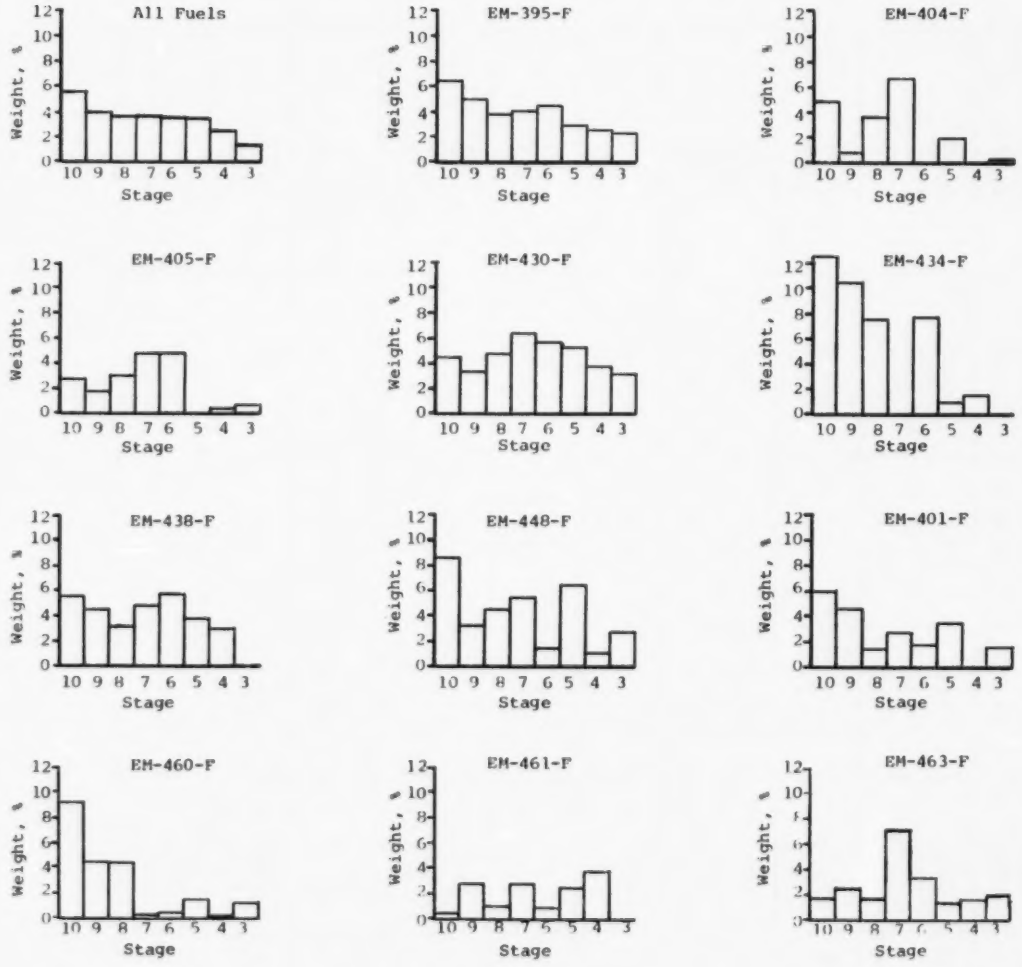

Figure 12. Weight percentage of particulate matter collected by impactors stage during an FTP.

TABLE 21. CARBON, HYDROGEN, AND NITROGEN IN EXHAUST PARTICULATE MATTER

Fuel	Cycle	Percent			Total Vehicle Particulate,[a] g/test
		Carbon	Hydrogen	Nitrogen	
EM-395-F	FTP_c	85.8	3.7	0.28	2.15
	FTP_h	89.6	4.7	0.26	1.95
	85 km/h	77.2	5.9	0.26	2.85
EM-404-F	FTP_c	86.0	5.0	<0.10	2.05
	FTP_h	87.9	5.6	<0.10	1.88
EM-405-F	FTP_c	84.5	5.4	<0.10	2.04
	FTP_h	87.1	5.0	<0.10	1.81
	85 km/h	84.8	6.5	<0.10	2.43
EM-430-F	FTP_c	79.7	2.5	0.26	2.53
	FTP_h	80.3	2.6	0.13	1.93
EM-434-F	FTP_c	84.0	2.8	0.48	2.59
	FTP_h	78.5	2.2	0.37	2.64
	85 km/h	85.1	2.6	0.28	4.61
EM-438-F	FTP_c	81.1	6.1	0.47	1.92
	FTP_h	77.2	6.1	0.70	1.81
EM-448-F	FTP_c	95.8	3.7	0.62	1.82
	FTP_h	76.6	2.9	0.45	1.58
EM-401-F	FTP_c	85.3	2.6	0.43	1.89
	FTP_h	73.9	2.6	0.35	1.72
	85 km/h	82.7	4.7	0.38	2.38
EM-460-F	FTP_c	86.0	2.1	0.32	2.68
	FTP_h	84.0	2.1	0.29	2.48
EM-461-F	FTP_c	82.7	2.4	0.43	2.05
	FTP_h	76.3	2.4	0.31	1.80
EM-463-F	FTP_c	82.9	1.5	0.31	3.39
	FTP_h	82.7	1.5	0.31	3.46

[a] Based on 47 mm Pallflex filter rate

analysis for particulate generated using each fuel is located in Appendix E, page E-13, along with other analyses. In some cases the oxygen appears to account for the "missing" material. In other cases, the oxygen analysis would account for far too much of the elemental composition (i.e., C + H + N + O percentage greater than 100). Additional work is needed to qualify oxygen analysis of particulate matter, because all the widely used bulk analysis techniques have difficulties with particulate matter.

Data on trace elements are given in Appendix E, pages E-15 through E-17. As a whole, these elements made up from about 0.6% to 2% of the particulate mass. The trace elements found most commonly in particulate matter were iron, sulfur, calcium, and zinc; and to a lesser degree aluminum and magnesium. Possible sources of iron and aluminum are wear products from engine and exhaust systems. Sulfur, calcium, and zinc are probably attributable to fuel sulfur and lubricating oil additives. An interesting observation is the increase of silicon during operation with the shale oil additive blend, EM-430-F. The increase may be related to contaminants introduced during shale oil extraction.

E. Composition of Organic Solubles in Particulate Matter

The amounts of organic solubles extracted from particulate matter collected on "20x20" filters are listed in Table 22. All blends containing aromatics resulted in slightly less organic soluble matter than the base fuel. Solubles were about the same for the fuel containing aromatics and cetane improver (EM-463-F) as they were for the fuel with these same aromatics only (EM-434-F). Olefins, light ends, and heavy ends were associated with increases in the amount of organic solubles. The 85 km/h results are also of some interest. The amount of organic solubles doubled (as compared to base fuel) on the three of the four blends tested. The three blends exhibiting high organic solubles at 85 km/h all had high paraffin content. The other blend, EM-434-F, contained 30 percent aromatics. Previous work[6] on this vehicle, using commercially available fuels, indicated about the same organic soluble content of the particulate matter on either an FTP or an 85 km/h cruise. All the fuels in that study contained over 12 percent aromatics. It is possible that highly paraffinic fuels create more variability in soluble fraction due to operating schedule variations than fuels with more aromatics.

1. Major elements in organic solubles

A portion of the organic soluble material was analyzed for carbon, hydrogen, nitrogen, sulfur, and oxygen. The results are given in Table 22. All the elemental data are indicative of hydrocarbon-like materials (numeric H/C ratio between 1.31 and 1.72). Sulfur and nitrogen are low. No apparent increase in nitrogen was seen as result of isoquinoline addition to the fuel. The oxygen levels varied somewhat, but with no clear trends detected.

TABLE 22. COMPOSITION OF ORGANIC SOLUBLES FROM PARTICULATE MATTER

Fuel	Cycle	Percent					Vehicle Total Solubles g/test[a]	% of Total Particulate
		Carbon	Hydrogen	Nitrogen	Sulfur	Oxygen		
EM-395-F base	FTP_c	78.6	10.9	0.37	0.88	6.7	0.314	14.8
	FTP_h	77.3	10.5	0.70	0.75	8.5	0.334	15.8
	85 km/h	79.0	10.7	0.81	0.60	8.3	0.857	30.1
EM-404-F base + iso.	FTP_c	78.5	10.8	0.70	0.32	8.2	0.268	13.0
	FTP_h	74.5	9.9	1.02	0.32	--	0.274	13.7
EM-405-F base ++ iso.	FTP_c	74.9	10.4	0.75	0.37	--	0.251	11.5
	FTP_h	83.7	12.8	1.00	0.38	--	0.182	9.7
	85 km/h	84.5	13.1	1.35	0.73	--	0.708	28.9
EM-434-F heavy aro.	FTP_c	72.0	8.5	1.30	1.64	12.3	0.332	12.8
	FTP_h	71.4	8.5	1.45	0.44	13.0	0.345	13.1
	85 km/h	75.7	9.9	0.73	0.92	8.9	0.707	16.4
EM-438-F olefins	FTP_c	74.5	9.4	1.35	0.66	13.1	0.331	17.6
	FTP_h	75.9	10.0	1.32	0.67	12.6	0.316	18.8
EM-448-F light-ends	FTP_c	73.0	9.1	0.97	0.58	14.7	0.388	18.4
	FTP_h	76.6	10.6	1.63	0.62	9.1	0.325	19.1
EM-401-F alt. base	FTP_c	80.1	11.5	1.02	0.51	5.7	0.265	13.8
	FTP_h	78.3	11.1	1.39	0.51	7.0	0.286	17.1
	85 km/h	74.6	9.0	1.56	0.75	11.5	0.693	31.2
EM-460-F pure aro.	FTP_c	82.1	12.0	0.23	0.40	--	0.333	12.9
	FTP_h	82.6	12.2	0.21	0.39	5.5	0.363	14.4
EM-461-F heavy-ends	FTP_c	83.0	12.3	0.20	0.43	4.3	0.337	16.6
	FTP_h	82.4	12.5	0.25	0.45	5.1	0.297	16.5
EM-463-F 434+cet.	FTP_c	82.8	12.4	0.23	0.44	4.3	0.402	11.9
	FTP_h	81.7	12.3	0.25	0.55	5.5	0.412	12.2

[a] Based on 47 mm Pallflex filter rate

2. Benzo-a-pyrene (BaP) in Organic Solubles

BaP in organic solubles was determined initially by EPA's Research Triangle Park laboratories as part of its in-house measurement program. Originally, each filter extract representing an FTP (either cold or hot) was analyzed separately for BaP. At the Project Officer's request, the filter extracts from a cold FTP and a hot FTP from each fuel were combined, and the analysis was performed by SwRI's Department of Emissions Research. The results of these analyses are shown in Table 23. Other, related data are also shown. The lowest BaP emissions occurred with the olefin blend, EM-438-F, and the highest level was observed with the shale oil blend, EM-430-F. The shale oil blend increased the BaP emissions by a factor of 3. This emission rate (0.96 µg/km) is not considered significant.

3. Gas Chromatograph "boiling range" Analysis of Organic Solubles

An additional aliquot of organic soluble material was submitted for boiling range determination by gas chromatography. The procedure was plagued with hardware problems for over a year during the conduct of this program. The delays have resulted in some apparent polymerization of the organic soluble material. Table 24 lists the results of the analysis. A previous study[6] indicated that the recovery of the material should be between 60 and 90 percent. Due to apparent polymerization, not all the organic soluble material could be re-dissolved in the G.C. solvent. Therefore, the weight of actual sample injected was not known accurately, invalidating the quantitative analysis. An example of a crude oil ("Altamont") and an organic extract chromatogram are located in Appendix E, Figures E-1 and E-2. It is obvious from this experience that boiling range determination by gas chromatography should be performed as soon as possible after extraction.

F. Mutagenic Activity of Organic Solubles

Organic soluble extracts representing the fuels tested were subjected to a complete series of Ames testing with five tester strains, in triplicate, with and without metabolic activation. The results, in revertants per microgram of extract, are summarized in Table 25. Two strains, TA-98 and TA-100, were fairly sensitive to particulate organic extractables, while the remaining three strains responded to a lesser degree. All of the responses were relatively low which was probably due to the clean base fuel. There appeared to be a trend towards higher activities with the aromatic blends. The trends with the isoquinoline blends were inconclusive. The heavy-end extended blend appeared to have increased the activity somewhat.

A comparison of distance-specific Ames activity is shown in Table 26. Table 26 takes into account the particulate rate and percent organic extractables of each fuel blend, resulting in Ames activity as revertants per kilometer. The largest increase in Ames response was associated with the heavy aromatic naptha (HAN)-cetane improver blend (EM-463-F) on strain TA-100 without activation. Greater than a threefold increase occurred as compared to the base

TABLE 23. BaP PRESENT IN ORGANIC SOLUBLES

CABS Sample No.	Filter No.	Cycle	Fuel EM-	Particulate Rate, mg/km	% Organic Extractables	% BaP in Extract	BaP Rate µg/km
-79-700	PL-1507	FTP_c	395-F	174	18.6	0.0014	0.47
-79-710	PL-1508	FTP_h	395-F	158	18.3	0.0019	0.58
-79-20	PL-1510	FTP_c	404-F	173	14.9	0.0010	0.25
-79-730	PL-1511	FTP_h	404-F	153	16.4	0.0011	0.26
-79-740	PL-1517	FTP_c	405-F	175	16.1	0.0013	0.37
-79-750	PL-1518	FTP_h	405-F	153	16.0	0.0013	0.33
-80-761	PL-1522,-1524	$FTP_c + FTP_h$	430-F	180	12.7	0.0042	0.96
-80-781	PL-1525,-1526	$FTP_c + FTP_h$	395-F	165	12.1	0.0033	0.65
-80-931	PL-1529,-1530	$FTP_c + FTP_h$	434-F	212	11.8	0.0015	0.37
-80-940	PL-1535	85 km/h	434-F	163	15.2	0.0017	0.41
-80-961	PL-1536,-1537	$FTP_c + FTP_h$	438-F	155	13.9	0.0010	0.21
-80-4101	5423-P20-30,-31	$FTP_c + FTP_h$	395-F	176	20.6	0.0015	0.27
-80-4111	5423-P20-9,-10	$FTP_c + FTP_h$	401-F	151	17.0	0.0028	0.42
-80-4121	5423-P20-61,-62	$FTP_c + FTP_h$	404-F	171	14.4	0.0030	0.52
-80-4131	5423-P20-63,-64	$FTP_c + FTP_h$	405-F	172	16.3	0.0022	0.37
-80-4141	5423-P20-7,-8	$FTP_c + FTP_h$	448-F	142	19.9	0.0029	0.51
-80-4151	5423-P20-27,-28	$FTP_c + FTP_h$	460-F	219	11.7	0.0033	0.73
-80-4161	5423-P20-26,-29	$FTP_c + FTP_h$	461-F	159	17.5	0.0027	0.43
-80-4171	5423-P20-38,-39	$FTP_c + FTP_h$	463-F	287	10.8	0.0015	0.43
-80-4181	5434-P20-32	85 km/h	395-F	99	41.4	0.0006	0.06
-80-4191	5423-P20-11	85 km/h	401-F	86	32.2	0.0014	0.12

TABLE 24. CHROMATOGRAPH ANALYSIS OF ORGANIC SOLUBLES IN PARTICULATE MATTER

Distillation Point	Boiling Temperature at Distillation Point by Fuel, °C, During Cold FTP[a]								
	EM-395-F	EM-404-F	EM-405-F	EM-434-F	EM-438-F	EM-448-F	EM-401-F	EM-460-F	EM-461-F	EM-463-F
IBP	280	290	288	282	282	300	280	280	289	266
10% point	376	405	384	377	378	471	383	375	404	354
20% point	398	437	407	399	399	-	408	395	449	377
30% point	419	465	429	420	419	-	431	414	511	398
40% point	441	502	450	441	437	-	454	432	-	422
50% point	462	-	469	462	456	-	477	449	-	447
60% point	486	-	493	484	474	-	515	466	-	472
70% point	533	-	536	523	498	-	-	487	-	506
80% point	-	-	-	-	551	-	-	526	-	597
90% point	-	-	-	-	-	-	-	-	-	-
EP	-	-	-	-	-	-	-	-	-	-
Recovery, %,	74.5	47.1	74.4	75.4	82.6	14.0	66.2	83.2	33.7	80.0

Distillation Point	Boiling Temperature at Distillation Point by Fuel, °C, During Hot FTP									
	EM-395-F	EM-404-F	EM-405-F	EM-434-F	EM-438-F	EM-448-F	EM-401-F	EM-460-F	EM-461-F	EM-463-F
IBP	266	287	272	277	285	274	276	280	235	274
10% point	375	403	445	379	380	458	378	374	467	374
20% point	396	432	543	402	401	-	401	395	-	397
30% point	415	457	-	424	421	-	425	414	-	419
40% point	435	481	-	446	441	-	448	433	-	442
50% point	452	519	-	467	460	-	470	451	-	464
60% point	472	-	-	493	480	-	498	469	-	488
70% point	497	-	-	545	511	-	566	490	-	530
80% point	547	-	-	-	-	-	-	530	-	-
90% point	-	-	-	-	-	-	-	-	-	-
EP	-	-	-	-	-	-	-	-	-	-
Recovery, %,	57.6	56.3	22.9	73.0	77.4	15.4	70.7	82.8	13.1	75.4

[a] possible quantitative inaccuracies due to sample storage

TABLE 25. SUMMARY OF AMES BIOASSAY ANALYSIS OF ORGANIC SOLUBLES FROM PARTICULATE MATTER COLLECTED DURING FTP

Fuel Code	Description	RLI-16 Activation	Model Predicted Mean Slope, revertants/µg extract				
			TA-1535	TA-1537	TA-1538	TA-98	TA-100
EM-395-F	base	No	0.0	0.2	0.7	3.2	3.9
		Yes	0.0	0.3	0.4	0.9	1.9
EM-404-F	base + isoquinoline (0.05% N)	No	0.0	0.7	1.7	3.3	5.1
		Yes	0.1	0.5	1.0	3.0	1.9
EM-405-F	base + isoquinoline (0.10% N)	No	0.0	0.1	0.5	1.9	5.5
		Yes	0.2	1.1	0.9	0.8	1.3
EM-430-F	base + shale oil cut	No	0.3	0.2	0.6	1.3	4.9
		Yes	0.0	0.2	0.7	1.0	1.9
EM-434-F	base + "HAN"	No	0.0	0.7	1.7	3.7	6.9
		Yes	0.1	0.5	1.1	1.1	2.2
EM-438-F	base + olefins	No	0.0	0.1	0.3	0.8	3.0
		Yes	0.0	0.2	0.5	1.3	1.2
EM-448-F	base + light ends	No	0.0	0.4	0.9	4.1	3.3
		Yes	0.1	1.3	0.7	0.9	1.4
EM-401-F	JP-7	No	0.0	0.2	1.4	3.0	--
		Yes	0.1	0.3	0.9	3.3	1.4
EM-460-F	base + individual aromatics	No	0.0	0.7	1.7	3.5	8.7
		Yes	0.1	0.4	0.9	2.9	2.6
EM-461-F	base + heavy ends	No	0.0	0.3	1.2	3.6	6.6
		Yes	0.1	0.5	1.0	2.7	2.3
EM-463-F	EM-434-F + cetane improver	No	0.0	0.7	1.7	5.7	14.0
		Yes	0.1	0.6	0.9	2.5	2.4

TABLE 26. AMES BIOASSAY ANALYSIS RESULTS IN REVERTANTS PER DISTANCE DURING FTP

Fuel Code	Description	RLI-16 Activation	Model Predicted Mean Slope, 10^3 revertants/km[a]				
			TA-1535	TA-1537	TA-1538	TA-98	TA-100
EM-395-F	base	No	0.0	7.	25.	112.	137.
		Yes	0.0	11.	14.	32.	67.
EM-404-F	base + isoquinoline (0.05% N)	No	0.0	16.	40.	77.	119.
		Yes	2.	12.	23.	70.	44.
EM-405-F	base + isoquinoline (0.10% N)	No	0.0	3.	13.	50.	145.
		Yes	5.	29.	24.	21.	34.
EM-430-F	base + shale oil cut	No	7.	5.	14.	30.	112.
		Yes	0.0	5.	16.	23.	43.
EM-434-F	base + "HAN"	No	0.0	18.	43.	93.	173.
		Yes	3.	13.	28.	28.	55.
EM-438-F	base + olefins	No	0.0	2.	6.	17.	65.
		Yes	0.0	4.	11.	28.	26.
EM-448-F	base + light ends	No	0.0	11.	25.	116.	93.
		Yes	3.	37.	20.	25.	40.
EM-401-F	JP-7	No	0.0	5.	36.	77.	--
		Yes	3.	8.	23.	85.	36.
EM-460-F	base + individual aromatics	No	0.0	18.	44.	90.	223.
		Yes	3.	10.	23.	74.	67.
EM-461-F	base + heavy ends	No	0.0	8.	33.	100.	184.
		Yes	3.	14.	28.	75.	64.
EM-463-F	EM-434-F + cetane improver	No	0.0	22.	53.	176.	433.
		Yes	3.	19.	28.	77.	74.

[a]calculation incorporates particulate mass rates based on 47 mm Pallflex filters, percent organic solubles extracted from Pallflex "20x20" filters, and data in Table 23.

fuel, EM-395-F. It is interesting to note that both these fuels, EM-463-F and EM-395-F, exhibited similar response on TA-100 with activation. Olefin blend EM-438-F gave the lowest response on all 5 strains with and without activation. For strain TA-100 without activation, fuel blends associated with the highest Ames responses were the three containing aromatics, and the heavy-end extended blend. In the majority of cases, metabolic activation reduced Ames activity on all 5 strains. This trend was much more pronounced for strains TA-1538, TA-100, and TA-98 than for the other two strains.

VIII. STATISTICAL ANALYSIS OF FUEL AND EMISSIONS DATA

This report section discusses the application of several statistical computer programs to fuel and emission variables. The principal goal was to determine linear relationships between intentionally-varied fuel variables and important emission variables.

A. Statistical Methodology

The statistical packages used for analysis of the data were SPSS (Statistical Package for the Social Sciences)[15] and BMDP (Biomedical Computer Programs).[16] Various programs from each of these packages were used to evaluate the data.

There are 38 fuel variables and 82 emission variables representing the 11 fuel blends tested. Pearson's correlation coefficients were calculated for these data, using a bivariate correlation procedure in order to determine the strengths of the association between all pairs of variables. This technique was used to reduce the number of variables so that regression analysis could be applied to the strong correlators between fuel and emission variables. Factor analysis also was applied to reduce the number of fuel variables to ones which are orthogonal to each other, yet retain physical meaning. Using both the bivariate correlation procedure and factor analysis, the fuel variables were reduced from 38 to 5, while the emission variables were reduced from 82 to 9. These reduced lists are considered to include the most important emissions and fuel variables.

A forward stepwise regression analysis was performed to determine the number of significant fuel variables to incorporate in a prediction equation for each emission variable. Included in the output from this analysis were the fuel variable coefficients as well as a variety of two-variable plots of fuel variables, emission variables, and residuals.

B. Data Input and Numbering of Variables

The raw data were stored in the computer as a data file which was "called up" as needed by various programs. All fuel and emission variables were assigned unique numerical variable codes to streamline computer formatting for the statistical packages. Table 27 is a list of these codes for reference. A brief summary of code intervals is as follows:

Codes	Variable Class
V1 - V38	fuel variables
V101 - V141	gaseous emission variables
V201 - V241	particulate emission variables

TABLE 27. CODING OF FUEL AND EMISSION VARIABLES

Code	Variable
V1	fuel cetane number
V2	fuel cetane index
V3	fuel gravity
V4	fuel density
V5	carbon in fuel
V6	hydrogen in fuel
V7	oxygen in fuel
V8	nitrogen in fuel
V9	H/C ratio in fuel
V10	aromatics in fuel
V11	olefins in fuel
V12	paraffins in fuel
V13	fuel viscosity
V14	fuel gum
V15	IBP by D86
V16	10% point by D86
V17	20% point by D86
V18	30% point by D86
V19	40% point by D86
V20	50% point by D86
V21	60% point by D86
V22	70% point by D86
V23	80% point by D86
V24	90% point by D86
V25	EP by D86
V26	residue by D86
V27	IBP by D2887
V28	10% point by D2887
V29	20% point by D2887
V30	30% point by D2887
V31	40% point by D2887
V32	50% point by D2887
V33	60% point by D2887
V34	70% point by D2887
V35	80% point by D2887
V36	90% point by D2887
V37	EP by D2887
V38	residue by D2887
V101	HC
V102	CO
V103	NO_x
V104	CO_2
V105	fuel consumption
V106	formaldehyde
V107	acetaldehyde
V108	acetone[a]
V109	isobutyraldehyde
V110	crotonaldehyde
V111	hexanaldehyde
V112	benzaldehyde
V113	total aldehydes
V114	methane
V115	ethane
V116	ethylene
V117	acetylene
V118	propane
V119	propylene
V120	benzene
V121	toluene
V122	total IHC (V114-V121)
V123	odor LCA
V124	odor LCO
V125	odor intensity, TIA
V126	phenol, filtered (f)
V127	salicylaldehyde, f
V128	m-cresol + p-cresol, f
V129	group 5[b], f
V130	2,3,5- trimethylphenol, f
V131	2,3,5,6-tetramethylphenol, f
V132	2-n-propylphenol, f
V133	sum of filtered phenols (V126-V132)
V134	phenol, unfiltered (u)
V135	salicylaldehyde, u
V136	m-cresol + p=cresol, u
V137	group 5[b], u
V138	2,3,5-trimethylphenol, u
V139	2,3,5,6-tetramethylphenol, u
V140	2-n-propylphenol, u
V141	sum of unfiltered phenol (V134-V140)
V201	total particualte mass rate
V202	solubles in particulate matter
V203	particulate carbon rate
V204	particulate hydrogen rate
V205	particulate nitrogen rate
V206	BaP in solubles
V207	Na in particulate matter
V208	Mg in particulate matter
V209	Al in particulate matter
V210	Si in particulate matter
V211	P in particulate matter
V212	S in particulate matter
V213	Cl in particulate matter
V214	Ca in particulate matter
V215	Ti in particulate matter
V216	Zn in particulate matter
V217	Sn in particulate matter
V218	Ba in particulate matter
V219	Fe in particulate matter
V220	Pb in particulate matter
V221	Br in particulate matter
V222	Cd in particulate matter
V223	K in particulate matter
V224	Ni in particulate matter
V225	V in particulate matter
V226	Sb in particulate matter
V227	total trace elements (V207-V226)
V228	cold start peak smoke
V229	cold idle average smoke
V230	1st acceleration peak smoke
V231	idle @ 125 secs, avg. smoke
V232	acceleration @ 164 secs. peak smoke
V233	carbon in solubles
V234	hydrogen in solubles
V235	nitrogen in solubles
V236	sulfur in solubles
V237	oxygen in solubles
V238	carbon in particualte
V239	hydrogen in particulate
V240	nitrogen in particualte
V241	100-(CHNS in particulate)

[a] plus acrolein and proponal

[b] group 5 represents p-ethylphenol + 2-isopropylphenol + 2,3-Xylenol + 3,5-Xylenol + 2,4,6-trimethylphenol

The computer data file was duplicated and additional information was added to serve as a reference listing. This listing is located in Appendix F, pages F-2 through F-7. The listing includes all the raw data values, variable code assignments, variable titles, and information concerning the column location of the data on computer data cards. The data stored in the data file are in units which are normally used when describing a particulate variable (e.g., density in g/mℓ, CO in g/km).

C. Analysis of Fuel Variables

Basic statistics were performed on fuel variables to provide a method for interpreting the distributions and magnitude of variations. Pearson correlation coefficients were calculated in order to study and compare the strength of association between pairs of fuel variables. This computation was performed to reduce the number of fuel variables to a few highly significant ones, by removing redundant and/or interrelated variables.

Basic statistics for the fuel variables are presented in Table 28. The data represent 11 fuels. 10 of which were modifications of a base fuel (with various compounds added). The most significant variability occurred among those properties which were intentionally modified for study in this project. The cetane number, nitrogen, aromatic, olefin and paraffin values reflect these changes. Both boiling point determinations show little variation, due to the magnitude of the means and the fact that only one test fuel contained lighter ends and one other test fuel contained heavier ends. Even with this information considered, the table shows that the variation increases slightly from the middle of the boiling points to higher end. The high coefficient of variation for gum reflects the unintentional increase of the gum level in the test fuel that contained a shale oil fraction. This coefficient is high because the gum level of the fuel containing shale oil, EM-430-F, was about 7 times as high as the other test fuels.

The skewness column in Table 28 lists the degree to which the distribution of variable values deviates from a normal curve for the 11 test fuels used. Skewness measures deviations from symmetry. The measure of skewness will be zero when the distribution is a completely symmetric bell-shaped curve. Positive values of skewness indicate that most of the variable values are clustered to the left or lower than the mean, with the extreme values to the right or higher than the mean. The opposite is true for negative skewness. The high positive skewness of the higher boiling points reflect the addition of the heavy-ends fuel EM-461-F, while the other fuels remained fairly constant. The same holds true for the negative skewness reflecting value for the light-ends fuel EM-448-F. Similar marked changes in skewness demonstrate the effect of altering the composition of the base fuel EM-395-F in other ways.

Kurtosis is a measure of the relative peakedness or flatness of the curve defined by a variable for the 11 test fuels used. A normal distribution will have a kurtosis of zero. If the kurtosis value is positive,

TABLE 28. BASIC STATISTICS FOR FUEL VARIABLES (V1-V38)

Fuel Variable No.	Fuel Variable Name	Mean	Standard deviation	Coefficient of variation	γ_1= skewness	γ_2= kurtosis
V1	cetane number	58.109	7.406	0.1274	-0.976	0.170
V2	cetane index	54.345	6.220	0.1145	-0.931	-0.556
V3	gravity	45.236	3.097	0.0685	-0.883	- 0.441
V4	density	0.801	0.014	0.0179	0.978	- 0.329
V5	carbon, %	85.600	0.700	0.0082	0.314	- 1.423
V6	hydrogen, %	13.945	0.670	0.0480	-0.142	- 1.991
V8	nitrogen, ppm	238.636	350.217	1.4676	1.072	- 0.374
V9	H/C	1.947	0.100	0.0515	-0.430	- 1.497
V10	aromatics	13.836	12.059	0.9394	1.133	- 0.795
V11	olefins	2.064	1.594	0.7724	2.726	7.973
V12	paraffins	85.091	11.964	0.1406	-1.061	- 0.859
V13	viscosity	1.565	0.095	0.0609	0.219	0.231
V14	gum	2.309	4.048	1.7531	3.112	9.991
V15	IBP (D86)	195.727	8.956	0.0458	-1.117	1.846
V16	10% (D86)	207.636	6.830	0.0329	-2.218	6.437
V17	20% (D86)	209.090	5.504	0.0262	-2.025	6.571
V18	30% (D86)	211.727	4.174	0.0197	-1.419	5.531
V19	40% (D86)	213.636	3.557	0.0166	-0.026	3.240
V20	50% (D86)	215.636	3.722	0.0173	0.578	1.312
V21	60% (D86)	218.182	3.920	0.0180	1.453	2.021
V22	70% (D86)	220.818	4.687	0.0212	1.444	1.239
V23	80% (D86)	224.364	6.038	0.0269	1.547	1.612
V24	90% (D86)	229.909	8.871	0.0386	1.559	2.159
V25	EP (D86)	258.545	10.930	0.0423	1.776	3.487
V27	IBP (D2887)	163.818	22.351	0.1364	0.218	-2.039
V28	10% (D2887)	196.091	12.333	0.0689	-2.060	4.663
V29	20% (D2887)	204.818	9.537	0.0466	-1.597	3.541
V30	30% (D2887)	212.000	5.477	0.0258	0.143	-0.854
V31	40% (D2887)	217.455	4.741	0.0218	0.603	-0.803
V32	50% (D2887)	221.909	4.206	0.0190	0.423	-1.630
V33	60% (D2887)	228.000	4.919	0.0216	0.351	-1.645
V34	70% (D2887)	234.182	4.535	0.0194	0.264	-2.109
V35	80% (D2887)	240.545	6.532	0.0272	1.127	0.882
V36	90% (D2887)	248.636	10.736	0.0432	1.115	0.592
V37	EP (D2887)	277.545	12.684	0.0457	0.826	-0.011

then the distribution is more peaked (narrow) than would be true for a normal distribution; while a negative value means that it is flatter. The high kurtosis values of gum and olefins represent the "jump" in one value causing a high peak for each respective variable. The negative values such as carbon and the middle boiling points of D2887 indicate a relatively flat distribution of data points. For the most part, the fuel variables exhibit a wide range of curve formations.

In order to reach the point at which a meaningful linear regression analysis could be performed, the number of fuel variables was reduced. Of the 38 fuel variables, 5 were determined to be unrelated to each other and representative of the fuel variables intentionally modified. The method used to determine the five variables incorporated both bivariate correlation analysis and factor analysis.

The bivariate correlation matrix for all fuel and emission variables is given in Appendix F, pages F-8 through F-31. The correlation coefficients for the two boiling point methods were extracted from this large matrix, and they are presented in Table 29. With the exception of a few pairwise correlations at the upper boiling percentages, the coefficients are very small. If the coefficients for corresponding boiling percentages (e.g., D86 20% pt. vs D2887 20% pt.) were high ($r \geq 0.95$), then the methods would be interchangeable. This would have allowed one method to be dropped because of redundancy. One possible explanation for the lack of correlation between these two methods is the lack of variability of the data. Nine of eleven test fuels were controlled to exhibit similar boiling ranges. With such a small variability in the boiling points, the procedural error became a strong influence in the variability of the results. The ASTM D86 method is more sensitive to human error and does not contain computer analysis as ASTM D2887 (gas chromatograph).

The fuel/emission variables correlation matrix in Appendix F indicated that D2887 generally exhibited higher correlation coefficients for "major" emissions than D86. Emissions that were considered "major" were particulate, HC, CO, NO_x, fuel consumption, BaP, total aldehydes, total phenols, and organic solubles. A brief scan of the other emissions also supported this finding. On this basis, ASTM D2887 was selected to represent the boiling points of the test fuels.

A factor analysis was performed on the remaining 26 fuel variables to determine those variables that are most orthogonal to each other, and to characterize the fuel variability mathematically. All the factor analysis data are located in Appendix F, pages F-32 through F-34.

Table 30 represents the "varimax rotated factor matrix", which is a small part of the entire factor analysis. This table is the terminal solution or orthogonally rotated factors. The numbers in a given row represent coefficients of factors to describe a given variable. A factor is a hypothetical parameter that is developed to describe a variable. For example, the most important determinant of density is Factor 1 (0.94593).

TABLE 29. CORRELATIONS BETWEEN BOILING PERCENTILES OBTAINED BY TWO ANALYSIS METHODS

ASTM D86 (thermal distillation) boiling range	Correlation coefficient (r) by ASTM D2887 (gas chromatograph simulated) boiling range											
	IBP var.27	10% var.28	20% var.29	30% var.30	40% var.31	50% var.32	60% var.33	70% var.34	80% var.35	90% var.36	EP var.37	Resi. var.38
IBP (var.15)	0.1911	0.6639	0.6081	0.3262	0.1822	0.0683	0.0250	0.0358	0.1737	0.0831	0.1661	-0.0640
10% (var.16)	0.1842	0.7958	0.7326	0.4384	0.2712	0.1449	0.1101	0.1250	0.2268	0.1753	0.4354	0.1148
20% (var.17)	0.2202	0.7736	0.7350	0.4578	0.3007	0.2156	0.2105	0.2251	0.3492	0.2973	0.5007	0.0657
30% (var.18)	0.2074	0.7039	0.6870	0.4331	0.2849	0.2548	0.2776	0.2988	0.4682	0.4105	0.5642	0.0217
40% (var.19)	0.1588	0.5137	0.5431	0.3490	0.2361	0.3184	0.3943	0.4322	0.6635	0.5932	0.6343	-0.0593
50% (var.20)	0.1530	0.3820	0.4515	0.3286	0.2653	0.4193	0.5297	0.5790	0.7739	0.7196	0.6380	-0.1458
60% (var.21)	0.1499	0.2499	0.3460	0.2841	0.2319	0.4378	0.5497	0.5999	0.8589	0.7859	0.6354	-0.1846
70% (var.22)	0.2479	0.2045	0.3348	0.3467	0.3282	0.5571	0.6810	0.7169	0.9280	0.8771	0.6462	-0.1994
80% (var.23)	0.2466	0.1754	0.3069	0.3296	0.3046	0.5330	0.6666	0.6913	0.9224	0.8847	0.6383	-0.2397
90% (var.24)	0.3308	0.2231	0.3603	0.4240	0.3816	0.5840	0.7058	0.7040	0.9345	0.9279	0.6804	-0.2209
EP (var.25)	0.5494	0.3668	0.4749	0.5412	0.4772	0.6124	0.7383	0.6757	0.8932	0.9367	0.7990	-0.1076
Resi. (var.26)	-0.3187	-0.1956	-0.1523	-0.0941	-0.1262	-0.0393	-0.1356	-0.0407	0.1055	0.0118	-0.2412	-0.3566

TABLE 30. VARIMAX ROTATED FACTOR MATRIX FOR REMAINING FUEL VARIABLES

Fuel Variable		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Cetane No.	(V1)	-0.75248	0.15970	0.13826	0.27294	0.30353
Centane Index	(V2)	-0.97866	-0.05976	-0.07934	-0.10583	-0.10205
Gravity	(V3)	-0.94593	-0.22712	-0.02729	-0.09619	-0.15418
Density	(V4)	0.94674	0.23824	0.03866	0.09042	0.14058
C	(V5)	0.88092	0.14900	-0.33911	-0.16595	0.26529
H	(V6)	-0.72097	-0.21143	-0.47595	0.27025	-0.24104
N	(V8)	0.06332	-0.12663	-0.10120	0.72318	0.23858
H/C	(V9)	-0.87870	-0.21323	-0.13330	0.24785	-0.27880
Aromatics	(V10)	0.97137	0.05098	0.09942	0.05366	0.02536
Olefins	(V11)	-0.12041	0.03498	0.77621	-0.22141	-0.00175
Paraffins	(V12)	-0.96071	-0.05157	-0.22671	-0.02436	-0.01973
Viscosity	(V13)	-0.48394	0.55881	-0.21885	0.11275	0.35796
Gum	(V14)	0.06430	-0.16577	-0.04057	-0.09366	0.61046
IBP[a]	(V27)	0.56895	0.50087	0.50750	0.09857	-0.03155
10%	(V28)	0.34588	0.31575	0.34642	0.42507	0.58673
20%	(V29)	0.41297	0.44891	0.33883	0.32564	0.59192
30%	(V30)	0.46239	0.56382	0.46674	0.20516	0.42473
40%	(V31)	0.55013	0.56195	0.53509	0.08045	0.28648
50%	(V32)	0.39906	0.76333	0.44849	-0.08691	0.11781
60%	(V33)	0.44312	0.85317	0.23411	-0.08738	-0.01912
70%	(V34)	0.34124	0.84680	0.24792	-0.16203	0.04010
80%	(V35)	-0.07278	0.98589	0.00912	-0.14523	-0.01735
90%	(V36)	0.05736	0.98487	-0.02988	-0.05929	-0.05230
EP	(V37)	-0.13636	0.75946	-0.13814	0.58977	-0.08859
Residue	(V38)	-0.13813	-0.10490	-0.07623	0.73422	-0.17898

[a]ASTM D2887

The remaining four factor coefficients are not as large. Therefore, the linear composition of density is controlled by Factor 1. Similarly, olefins are controlled by Factor 3. Since the matrix represents orthogonally rotated factors, density and olefins are statistically independent of one another. Those variables which are controlled by more than one factor measure more than one theoretical dimension, and therefore the compositions of those variables are complex.

Fuel variables selected from Table 30 were those controlled by one factor, preferably different for each variable. It was also important to select, if possible, those fuel variables whose levels were intentionally changed for study. Factor 3 was represented by olefins. The low boiling percentiles are spread across all five factors, and therefore their composition is too complex. Nitrogen was the choice from Factor 4 because the only other candidate, residue, does not contain the desired variability in the raw data. The only viable candidate in Factor 5 was gum. Although gum levels were not intentionally changed, they varied as a result of developing the test fuels for study. Factors 1 and 2 control several fuel variables. Those candidates and their bivariate correlation coefficients are presented in Table 29. Paraffins were omitted because they are inversely proportional to aromatics. This table shows the strong dependencies of cetane index, gravity, density, H/C, and aromatics on each other. Aromatics were chosen to characterize this group. Cetane number does not exhibit strong correlations with those variables in Factor 1. Factor 1 representatives were cetane number and aromatics. The upper boiling percentiles describe Factor 2. Table 31 again shows that the 50% to 90% points can be characterized by the 90% point. The end point does not exhibit high correlations. Factor 2 selections were the 90% point and end point.

D. Analysis of Emission Variables

The bivariate correlation matrix of all emission variables against one another is given in Appendix F, pages F-35 through F-70. There are two sets of phenol emissions. As discussed earlier in the report, the major difference in the two sets of phenol results was the filtering or non-filtering of the dilute exhaust gas sample. The correlation coefficients for these two methods were extracted from the larger matrix, and are presented in Table 32. With the exception of 2-n-propylphenol (V132 and V140), the two sets of phenol results do not exhibit a linear relationship. It would have been desirable to represent all the phenol data with one set or the other, but this simplification was not feasible.

The symmetric emission-emission correlation matrix contains over 6500 (82x82) elements. Analyzing such a large matrix for linear relationships would be extremely time-consuming. It was decided to select a set of ten emission variables considered most important. They included: total particulate, HC, CO, NO_x, fuel consumption, BaP, solubles, total aldehydes, total filtered phenols, and total unfiltered phenols. The correlation coefficients for these ten variables against each other are summarized

TABLE 31. CORRELATION COEFFICIENTS BETWEEN SELECTED FUEL VARIABLES (r≥0.85)

Fuel Variables	cet.no. (V1)	cet.ind. (V2)	grav. (V3)	dens. (V4)	H/C (V9)	aro. (V10)	50% (V32)	60% (V33)	70% (V34)	80% (V35)	90% (V36)	EP (V37)
cetane number (V1)	1.0000	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]
cetane index (V2)		1.0000	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]
gravity (V3)		0.9806	1.0000	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]
density (V4)		-0.9807	-0.9993	1.0000	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]
H/C (V9)		0.8894	0.9042	-0.9037	1.0000	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]
aromatics (V10)		-0.9479	-0.9232	0.9281	-0.8546	1.0000	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]
50% pt. (V32)							1.0000	---[a]	---[a]	---[a]	---[a]	---[a]
60% pt. (V33)							0.9618	1.0000	---[a]	---[a]	---[a]	---[a]
70% pt. (V34)							0.9552	0.9772	1.0000	---[a]	---[a]	---[a]
80% pt. (V35)										1.0000	---[a]	---[a]
90% pt. (V36)								0.8596		0.9713	1.0000	---[a]
EP (V37)												1.0000

[a] redundant values omitted

TABLE 32. CORRELATIONS BETWEEN FILTERED AND UNFILTERED PHENOLS

Filtered Phenols	Correlation Coefficient (r) Unfiltered Phenols							
	V134	V135	V136	V137	V138	V139	V140	V141
V126	-0.1583	0.6228	un[a]	0.0079	un	0.5487	-0.0914	0.4099
V127	0.6594	0.3835	un	-0.1967	un	-0.1709	0.9856	0.6543
V128	-0.1349	0.6235	un	0.0221	un	0.5373	-0.943	0.6543
V129	-0.0862	-0.5026	un	-0.2325	un	0.1566	-0.3626	0.4000
V130	-0.1540	0.4820	un	-0.1900	un	0.6023	-0.1056	-0.2146
V131	-0.1185	0.4744	un	-0.1750	un	0.5967	-0.1318	0.4181
V132	0.5708	0.6042	un	-0.1798	un	0.0578	0.8792	0.7698
V133	0.6399	0.4530	un	-0.2115	un	-0.0914	0.9661	0.7063

[a]un = uncomputable

Variable Definition

V126, V134 = phenol
V127, V135 = salicylaldehyde
V128, V136 = m-cresol + p-cresol
V129, V137 = p-ethylphenol + 2-isopropylphenol + 2,3-xylenol + 3,5-xylenol + 2,4,6-trimethylphenol
V130, V138 = 2,3,5-trimethylphenol
V131, V139 = 2,3,5,6-tetramethylphenol
V132, V140 = 2-n-propylphenol
V133, V141 = sum of phenols

in Table 33. Particulate correlates strongly with CO and moderately with NO_x. Hydrocarbons correlate moderately with CO. The remaining emission variables in Table 33 indicate linear independence of each other.

E. Relationships Between Fuel and Emission Variables

The previous sections have described reduction of the large number of fuel-emissions variables from 38 and 82 to 7 and 10, respectively. To construct linear regressions predicting emissions from fuel variables, Table 34 was assembled to determine which fuel variables are highly correlated to the ten selected emission variables. The total unfiltered phenols have the poorest correlation coefficients. It was felt that there would not be a good chance of unfiltered phenols being linearly related to fuel composition. Since phenols are represented by the filtered phenols, the unfiltered phenols were dropped from consideration in linear regression analysis.

Table 35 is a condensed version of Table 34. It was constructed by dropping unfiltered phenols and those fuel variables which are highly related to each other. For example, paraffins were dropped when aromatics appeared, because they are inversely proportional to each other. Of the fuel variables in Table 35, five of the seven selected in Section C are represented. The two that are absent, cetane number and 90% point, are not linearly related to the selected emission variables. Cetane number and 90% point were, therefore, dropped from consideration in linear regression analysis.

A stepwise linear regression analysis was conducted between each of the emissions variables versus the five fuel variables. For a particular emission variable, the stepwise linear regression analysis inserted the fuel variable or combination of fuel variables which exhibited the highest correlation with that emission variable. The output at each step included multiple R, multiple R-squared, standard error of the estimate, the constant term and the fuel variable regression coefficients. The criteria for determining the set of fuel variables to use for a particular emission variable were R-square value, standard error of estimate, and percent increase in R-square value. The R-square value reflects the strength of association between the two variables. The standard error of estimate describes the magnitude of the standard deviation for a given equation. An abbreviated example of the computer-output for one such analysis is given in Appendix F, pages F-71 through F-77.

A summary of the stepwise linear regression analysis is presented in Table 36. Those cases in which the regression coefficients were calculated as 0.000 indicate that the coefficients require more than three decimal places. In most cases the cutoff points for choosing fuel variables were determined where the standard error of estimate rose between steps. This rise reflected an increase in the standard deviation of predicted values, and therefore greater unpredictability. In other cases, the cutoff point was defined by an increase in the R-square of less than 0.01. A multiple linear regression analysis was performed on each emission variable based on the findings of the stepwise regression analysis.

TABLE 33. SUMMARY OF SELECTED EMISSION - EMISSION CORRELATION COEFFICIENTS

Emission Variables	Correlation Coefficients r									
	HC (V101)	CO (V102)	NO_x (V103)	fuel (V105)	tot.ald. (V113)	tot.phen., f[a], (V133)	tot.phen., un[b] (V141)	part. (V201)	solubles (V202)	BaP (V206)
HC (V101)	1.0000	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]
CO (V102)	0.8393	1.0000	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]
NO_x (V103)	0.6514	0.7439	1.0000	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]
fuel (V105)	-0.2343	-0.1074	0.1743	1.0000	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]
tot. ald. (V113)	-0.3387	-0.5219	-0.0168	-0.1987	1.0000	---[a]	---[a]	---[a]	---[a]	---[a]
tot. phenols f[a] (V133)	-0.2740	-0.0967	-0.0962	0.4655	-0.0799	1.0000	---[a]	---[a]	---[a]	---[a]
tot. phenols un[b] (V141)	-0.5556	-0.5148	0.2182	0.2080	0.5373	0.7063	1.0000	---[a]	---[a]	---[a]
particulate (V201)	0.6937	0.9440	-0.8349	-0.0199	-0.4185	-0.0526	-0.3819	1.0000	---[a]	---[a]
solubles (V202)	-0.0773	-0.3722	0.4112	0.1283	-0.0770	-0.3639	-0.2036	-0.5285	1.0000	---[a]
BaP (V206)	0.1996	0.2752	0.0489	0.0963	-0.2449	0.6904	0.3943	1.1611	-0.1590	1.0000

[a] filtered
[b] unfiltered
[c] redundant values omitted

TABLE 34. MULTIPLE COMPARISONS OF PAIRWISE CORRELATIONS BETWEEN IMPORTANT EMISSION VARIABLES AND FUEL VARIABLES

Emission Variable	Mean Value of variable	Pairwise correlations between fuel variables and indicated emission variables									
		highest	r	2nd highest	r	3rd highest	r	4th highest	r	5th highest	r
part. (V201)	181.8182	dens. (V4)	0.8888	cet. in. (V2)	-0.8850	grav. (V3)	-0.8804	aro. (V10)	0.8740	para. (V12)	-0.8495
BaP (V206)	0.4773	gum (V14)	0.7300	EP[a] (V37)	-0.4853	ole. (V11)	-0.4258	C (V5)	0.4043	70% pt[a] (V34)	-0.3883
HC (V101)	0.1009	H/C (V9)	-0.8073	aro. (V10)	0.7965	para. (V12)	-0.7856	cet. in. (V2)	-0.7771	C (V5)	0.7749
CO (V102)	0.5236	cet. in. (V2)	-0.9050	aro. (V10)	0.9038	dens. (V4)	0.9015	grav. (V3)	-0.8938	H/C (V9)	-0.8537
NO_x (V103)	0.8636	dens. (V4)	0.7388	grav. (V3)	-0.7314	aro. (V10)	0.7094	cet. in. (V2)	-0.7100	H/C (V9)	-0.7037
fuel (V105)	9.5991	ole. (V11)	0.6367	gum (V14)	0.5083	cet. # (V1)	0.4692	IBP[2] (V15)	0.4336	H (V6)	-0.4128
solubles (V202)	14.6000	N (V8)	-0.7753	cet. in. (V2)	0.5633	grav. (V3)	0.5602	dens. (V4)	-0.5428	10% pt[a] (V28)	-0.5338
tot. ald (V113)	3.6827	resi.[a] (V38)	0.7511	EP[a] (V37)	0.6007	H (V6)	0.5152	H/C (V9)	0.4853	para (V12)	0.4064
phenols,f[c] (V133)	15.1355	gum (V14)	0.9456	resi.[b] (V26)	0.5648	N (V8)	0.3934	60% pt[a] (V33)	-0.3316	EP[b] (V25)	-0.3210
phenols,un[d] (V141)	1.8327	gum (V14)	0.5587	dens. (V4)	-0.5079	H (V6)	0.5074	grav. (V3)	0.5005	cet. in. (V2)	0.4936

[a] ASTM D-2887
[b] ASTM D-86
[c] total filtered
[d] total unfiltered

TABLE 35. CONDENSED COMPARISON OF PAIRWISE CORRELATIONS BETWEEN IMPORTANT EMISSION VARIABLES AND FUEL VARIABLES[a]

Emission Variable	Mean Value of variable	Pairwise correlations between fuel variables and indicated emission variables					
		highest	r	2nd highest	r	3rd highest	r
part. (V201)	181.8182	dens. (V4)	0.8888	cet. in. (V2)	0.8850	aro. (V10)	0.8740
BaP (V206)	0.4773	gum (V14)	0.7300	EP[b] (V37)	-0.4853	ale. (V11)	-0.4258
HC (V101)	0.1009	H/C (V9)	-0.8073	aro. (V10)	-0.7965	cet. in. (V2)	-0.7771
CO (V102)	0.5236	cet. in. (V2)	-0.9050	aro. (V10)	0.9038	dens. (V4)	0.9015
NO_x (V103)	0.8636	dens. (V4)	0.7388	aro. (V10)	0.7094	cet. in. (V2)	-0.7100
fuel (V105)	9.5991	ole. (V11)	0.6367	gum (V14)	0.5083	cet. # (V1)	0.4692
solubles (V202)	14.6000	N (V8)	-0.7753	cet. in. (V2)	0.5633	10% pt[b] (V28)	-0.5388
tot. ald. (V113)	3.6827	resi.[b] (V38)	0.7511	EP[b] (V37)	0.6007	H (V6)	0.5152
phenols,f[d] (V133)	15.1355	gum (V14)	0.9456	resi.[c] (V26)	0.5648	N (V8)	0.3934

[a] This table removed those values in Table 32 that are related to one another, e.g., for density and gravity only density was used.
[b] ASTM D-2887
[c] ASTM D-86
[d] total filtered

TABLE 36. SUMMARY OF THE STEPWISE LINEAR REGRESSION ANALYSIS

Emission Variable	Step	Fuel Variable Entered	Multiple R-squared	Increase in R-squared	Std. Error of Estimate	Y-Intercept	Regression Coefficients				
							Aromatics	Nitrogen	Gum	Olefins	EP
HC	1	Aromatics	0.6344	0.6344	0.0126	0.084	0.001	--	--	--	--
	2	EP	0.7088	0.0744	0.0119	0.203	0.001	--	--	--	-0.000
	3	Gum	0.7417	0.0330	0.0120	0.228	0.001	--	-0.001	--	-0.001
	4	Olefins	0.7549	0.0132	0.0126	0.245	0.001	--	-0.001	-0.001	-0.001
	5	Nitrogen	0.7706	0.0157	0.0134	0.244	0.001	-0.000	-0.001	-0.002	-0.000
CO	1	Aromatics	0.8169	0.8169	0.0296	0.461	0.005	--	--	--	--
	2	EP	0.8307	0.0138	0.0302	0.630	0.005	--	--	--	-0.001
	3	Olefins	0.8447	0.0140	0.0309	0.684	0.005	--		-0.005	-0.001
	4	Gum	0.8461	0.0014	0.0332	0.665	0.005	--	0.001	-0.005	-0.001
NO_x	1	Aromatics	0.5033	0.5033	0.0547	0.808	0.004	--	--	--	--
	2	Nitrogen	0.6030	0.0997	0.0519	0.793	0.004	0.000	--	--	--
	3	EP	0.6374	0.0344	0.0530	0.479	0.004	0.000	--	--	0.001
	4	Olefins	0.6434	0.0059	0.0568	0.447	0.004	0.000	--	0.004	0.001
Fuel	1	Olefins	0.4054	0.4054	0.0895	9.508	--	--	--	0.044	--
	2	Gum	0.6924	0.2871	0.0683	9.471	--	--	0.015	0.046	--
	3	EP	0.7439	0.0515	0.0666	8.870	--	--	0.017	0.050	0.002
	4	Nitrogen	0.7511	0.0072	0.0709	8.948	--	0.000	0.016	0.051	0.002
	5	Aromatics	0.7534	0.0023	0.0773	8.970	-0.000	0.000	0.016	0.050	0.002
Particulate	1	Aromatics	0.7639	0.7639	21.7520	142.305	3.078	--	--	--	--
	2	Nitrogen	0.8392	0.0753	19.0394	134.935	3.033	0.033	--	--	--
	3	Olefins	0.8423	0.0030	20.1608	138.846	3.011	0.031	--	-1.538	--
	4	Gum	0.8431	0.0008	21.7216	138.447	3.007	0.031	0.304	-1.561	--

TABLE 36 (Cont'd). SUMMARY OF THE STEPWISE LINEAR REGRESSION ANALYSIS

Emission Variable	Step	Fuel Variable Entered	Multiple R-squared	Increase in R-squared	Std. Error of Estimate	Y-Intercept	Regression Coefficients				
							Aromatics	Nitrogen	Gum	Olefins	EP
BaP	1	Gum	0.5329	0.5329	0.1560	0.387	--	--	0.039	--	--
	2	Olefins	0.6891	0.1562	0.1350	0.500	--	--	0.038	-0.054	--
	3	EP	0.8496	0.1605	0.1004	2.590	--	--	0.031	-0.068	-0.007
	4	Nitrogen	0.8910	0.0414	0.0923	2.221	--	-0.000	0.036	-0.073	-0.006
	5	Aromatics	0.8925	0.0015	0.1004	2.187	0.001	-0.000	0.036	-0.073	-0.006
Solubles	1	Nitrogen	0.6011	0.6011	1.7474	15.987	--	-0.006	--	--	--
	2	Aromatics	0.7634	0.1622	1.4276	17.080	-0.088	-0.006	--	--	--
	3	Olefins	0.7956	0.0322	1.4186	16.293	-0.083	-0.005	--	0.309	--
	4	Gum	0.8038	0.0082	1.5010	16.372	-0.083	-0.005	-0.061	0.314	--
	5	EP	0.8170	0.0132	1.5881	24.142	-0.085	-0.005	-0.093	0.280	-0.028
Tot. Ald.	1	EP	0.3609	0.3609	4.2859	-63.176	--	--	--	--	0.241
	2	Aromatics	0.4688	0.1079	4.1445	-58.535	-0.139	--	--	--	0.231
	3	Olefins	0.4909	0.0221	4.3375	-53.326	-0.148	--	--	-0.492	0.216
	4	Gum	0.5045	0.0136	4.6219	-48.664	-0.148	--	-0.154	-0.536	0.201
	5	Nitrogen	0.5189	0.0144	4.9887	-43.442	-0.150	0.002	-0.213	-0.460	0.180
Tot. Phen.	1	Gum	0.8941	0.8941	13.1753	-5.581	--	--	8.972	--	--
	2	Aromatics	0.9316	0.0375	11.2270	2.165	-0.618	--	9.051	--	--
	3	Nitrogen	0.9631	0.0315	8.8170	-1.388	-0.639	0.020	8.635	--	--
	4	EP	0.9659	0.0028	9.1569	49.533	-0.654	0.023	8.417	--	-0.183
	5	Olefins	0.9671	0.0012	9.8477	57.616	-0.669	0.022	8.403	-0.900	-0.204

TABLE 36 (Cont'd). SUMMARY OF THE STEPWISE LINEAR REGRESSION ANALYSIS

Emission Variable	Step	Fuel Variable Entered	Multiple R-squared	Increase in R-squared	Std. Error of Estimate	Y-Intercept	Regression Coefficients				
							Aromatics	Nitrogen	Gum	Olefins	EP
BaP	1	Gum	0.5329	0.5329	0.1560	0.387	--	--	0.039	--	--
	2	Olefins	0.6891	0.1562	0.1350	0.500	--	--	0.038	-0.054	--
	3	EP	0.8496	0.1605	0.1004	2.590	--	--	0.031	-0.068	-0.007
	4	Nitrogen	0.8910	0.0414	0.0923	2.221	--	-0.000	0.036	-0.073	-0.006
	5	Aromatics	0.8925	0.0015	0.1004	2.187	0.001	-0.000	0.036	-0.073	-0.006
Solubles	1	Nitrogen	0.6011	0.6011	1.7474	15.987	--	-0.006	--	--	--
	2	Aromatics	0.7634	0.1622	1.4276	17.080	-0.088	-0.006	--	--	--
	3	Olefins	0.7956	0.0322	1.4186	16.293	-0.083	-0.005	--	0.309	--
	4	Gum	0.8038	0.0082	1.5010	16.372	-0.083	-0.005	-0.061	0.314	--
	5	EP	0.8170	0.0132	1.5881	24.142	-0.085	-0.005	-0.093	0.280	-0.028
Tot. Ald.	1	EP	0.3609	0.3609	4.2859	-63.176	--	--	--	--	0.241
	2	Aromatics	0.4688	0.1079	4.1445	-58.535	-0.139	--	--	--	0.231
	3	Olefins	0.4909	0.0221	4.3375	-53.326	-0.148	--	--	-0.492	0.216
	4	Gum	0.5045	0.0136	4.6219	-48.664	-0.148	--	-0.154	-0.536	0.201
	5	Nitrogen	0.5189	0.0144	4.9887	-43.442	-0.150	0.002	-0.213	-0.460	0.180
Tot. Phen.	1	Gum	0.8941	0.8941	13.1753	-5.581	--	--	8.972	--	--
	2	Aromatics	0.9316	0.0375	11.2270	2.165	-0.618	--	9.051	--	--
	3	Nitrogen	0.9631	0.0315	8.8170	-1.388	-0.639	0.020	8.635	--	--
	4	EP	0.9659	0.0028	9.1569	49.533	-0.654	0.023	8.417	--	-0.183
	5	Olefins	0.9671	0.0012	9.8477	57.616	-0.669	0.022	8.403	-0.900	-0.204

TABLE 36 (Cont'd). SUMMARY OF THE STEPWISE LINEAR REGRESSION ANALYSIS

Emission Variable	Step	Fuel Variable Entered	Multiple R-squared	Increase in R-squared	Std. Error of Estimate	Y-Intercept	Regression Coefficients				
							Aromatics	Nitrogen	Gum	Olefins	EP
BaP	1	Gum	0.5329	0.5329	0.1560	0.387	--	--	0.039	--	--
	2	Olefins	0.6891	0.1562	0.1350	0.500	--	--	0.038	-0.054	--
	3	EP	0.8496	0.1605	0.1004	2.590	--	--	0.031	-0.068	-0.007
	4	Nitrogen	0.8910	0.0414	0.0923	2.221	--	-0.000	0.036	-0.073	-0.006
	5	Aromatics	0.8925	0.0015	0.1004	2.187	0.001	-0.000	0.036	-0.073	-0.006
Solubles	1	Nitrogen	0.6011	0.6011	1.7474	15.987	--	-0.006	--	--	--
	2	Aromatics	0.7634	0.1622	1.4276	17.080	-0.088	-0.006	--	--	--
	3	Olefins	0.7956	0.0322	1.4186	16.293	-0.083	-0.005	--	0.309	--
	4	Gum	0.8038	0.0082	1.5010	16.372	-0.083	-0.005	-0.061	0.314	--
	5	EP	0.8170	0.0132	1.5881	24.142	-0.085	-0.005	-0.093	0.280	-0.028
Tot. Ald.	1	EP	0.3609	0.3609	4.2859	-63.176	--	--	--	--	0.241
	2	Aromatics	0.4688	0.1079	4.1445	-58.535	-0.139	--	--	--	0.231
	3	Olefins	0.4909	0.0221	4.3375	-53.326	-0.148	--	--	-0.492	0.216
	4	Gum	0.5045	0.0136	4.6219	-48.664	-0.148	--	-0.154	-0.536	0.201
	5	Nitrogen	0.5189	0.0144	4.9887	-43.442	-0.150	0.002	-0.213	-0.460	0.180
Tot. Phen.	1	Gum	0.8941	0.8941	13.1753	-5.581	--	--	8.972	--	--
	2	Aromatics	0.9316	0.0375	11.2270	2.165	-0.618	--	9.051	--	--
	3	Nitrogen	0.9631	0.0315	8.8170	-1.388	-0.639	0.020	8.635	--	--
	4	EP	0.9659	0.0028	9.1569	49.533	-0.654	0.023	8.417	--	-0.183
	5	Olefins	0.9671	0.0012	9.8477	57.616	-0.669	0.022	8.403	-0.900	-0.204

The resulting prediction equations are as follows:

V201 $\hat{\text{particulate}}$ (mg/km) = 135 + 3.03 (% aromatics) + 3.33×10^{-2} (ppm N)
$R^2 = 0.839$

V206 $\hat{\text{BaP}}$ (µg/km) = 2.59 - 6.78×10^{-2} (% olefins) + 3.14×10^{-2} (gum, mg/100mℓ)
- 7.37×10^{-3} (EP, °C) $R^2 = 0.850$

V101 $\hat{\text{HC}}$ (g/km) = 0.08 + 1.30×10^{-3} (% aromatics)
$R^2 = 0.634$

V102 $\hat{\text{CO}}$ (g/km) = 0.46 + 4.92×10^{-3} (% aromatics)
$R^2 = 0.817$

V103 $\hat{\text{NO}_x}$ (g/km) = 0.79 + 0.07×10^{-3} (ppm N) + 4.24×10^{-3} (% aromatics)
$R^2 = 0.603$

V105 $\hat{\text{fuel}}$ (ℓ/100 km) = 8.87 + 4.96×10^{-2} (% olefins) + 1.66 10^{-2} (gum,
mg/100mℓ) + 2.21×10^{-3} (EP, °C) $R^2 = 0.744$

V202 $\hat{\text{solubles}}$ (%) = 16.3 - 5.29×10^{-3} (ppm N) - 8.33×10^{-2} (% aromatics)
+ 0.31 (% olefins) $R^2 = 0.796$

V133 $\hat{\text{total phenols}}$ (mg/km) = -1.39 + 0.02 (ppm N) - 0.64 (% aromatics)
+ 8.63 (gum, mg/100mℓ) $R^2 = 0.963$

V113 $\hat{\text{total aldehydes}}$ (mg/km) = -58.54 + 0.23 (EP, °C) - 0.14 (% aromatics)
$R^2 = 0.469$

In reviewing the equations, it is obvious that total aldehydes, HC, NO_x, and fuel consumption have low R-square values and therefore are not strongly related (in the linear sense) to the five fuel variables chosen for study. The total phenol equation is misleading in that it contains a negative constant term. This outcome implies that fuels with low gum and nitrogen would emit a negative amount of phenols. The R-square value is high (0.963) implying a good linear fit. Review of the raw data indicates that in most cases the phenol levels were clustered together. In one case, however, the phenol level was very high. The multiple linear regression analysis essentially took the clustered cases as one point, and the high value as another. This situation would explain the small variance seen on phenols, but does not accurately explain those cases clustered on the low end.

An additional statistical program, "Scattergram", was also run to present the relationships between fuel and emission variables visually. A scattergram is a plot of two variables. Cetane number, aromatics, olefins, gum, nitrogen, and end point were plotted against HC, CO, NO_x, fuel consumption, particulate, solubles, BaP, total aldehydes, and total phenols. All fifty-four plots are located in Appendix F, pages F-78 through F-104. The scattergrams show, in many cases, a clustering of data points

and a lone point considerably distant from the cluster. As previously stated, this condition may result in deceptively high R-square values for the linear regression equations. This pattern is present in the BaP vs olefins and BaP vs gum plots. The BaP vs end point plot shows a random scatter of points. These types of trends could explain the large R-square and small regression coefficients of the linear equations. With the possible exception of particulate, most of the regression equations contain constant terms close to the mean of the respective emission variables. The major weaknesses of these equations is that they do not represent a true population dispersion of "real world" variability in fuel composition. It also should be noted that they define emissions for only one vehicle over one driving cycle (FTP). They do, however, show that certain trends can be seen and that relationships other than linear may exist.

The eleven test fuel blends were ranked according to their effect on each of the nine selected emissions. The fuel blend which exhibited the highest value for a particular emission was ranked number one and the blends which exhibited the lowest value was ranked number 11. Equal values were ranked equally. The ranking by this method is given in Table 37. The rank values were summed to express the typical frequency with which each fuel blend ranked high. Fuel blend EM-460-F (30% pure aromatics) indicated the lowest total rank value, and therefore exhibited higher emissions. The fuel blend containing heavy aromatics and a cetane improver, EM-463-F, ranked second highest. The base fuel, EM-395-F, was ranked fifth. The scatter of individual rankings for various emissions reflect the effects of modifying the base fuel EM-395-F. Test fuel EM-404-F, which was the base fuel + isoquinoline to 0.04% N, was associated with the lowest typical emission values.

TABLE 37. RANKING OF TEST FUELS AGAINST MAJOR EMISSIONS

Emissions	Test Fuels EM-XXX-F										
	395	401	404	405	430	434	438	448	460	461	463
Particulate	5	10	6	6	4	3	9	11	2	8	1
BaP	3	7	10	9	1	8	11	4	2	5	5
HC	6	4	9	9	6	3	6	4	1	9	1
CO	4	6	9	11	5	3	7	7	2	9	1
NO_x	10	6	11	3	8	4	6	9	2	5	1
Fuel Consumption	9	7	11	5	2	8	1	9	6	3	4
Solubles	4	5	7	11	9	8	2	1	6	3	10
Total Aldehydes	6	4	7	1	8	5	8	3	8	2	8
Total Phenols	4	11	3	2	1	6	10	8	5	7	9
Σ Rank Value	51	60	73	57	44	48	60	56	34	51	40

REFERENCES

1. Federal Register, Vol. 44, No. 23, Part IV, Thursday, February 1, 1979.

2. Smith, L. R., Parness, M. A., Fanick, E. R., and Dietzmann, H. E., "Analytical Procedures for Characterizing Unregulated Emissions from Vehicles Using Middle-Distillate Fuels." Interim Report, Contract 68-02-2497, U.S. Environmental Protection Agency, Office of Research and Development, April 1980.

3. Hare Charles T., "Methodology for Determining Fuel Effects on Diesel Particulate Emissions." EPA-650/2-75-056, U.S. Environmental Protection Agency, Office of Research and Development, March 1975.

4. Hare, Charles, T., Springer, Karl J., and Bradow, Ronald L., "Fuel and Additive Effects on Diesel Particulate-Development and Demonstration of Methodology." SAE Paper No. 760130, Detroit, Michigan, February 1976.

5. Hare, Charles T., "Characterization of Diesel Gaseous and Particulate Emissions." Draft Final Report of Tasks 1, 2, 4 and 6, Contract No. 68-02-1777, U.S. Environmental Protection Agency, September 1977.

6. Hare, Charles T., "Characterization of Gaseous and Particulate Emissions From Light-Duty Diesels Operated on Various Fuels." Final Report, Contract 68-03-2440, U.S. Environmental Protection Agency, July 1979.

7. Springer, Karl J., "Investigation of Diesel-Powered Vehicle Emissions VII." Interim Report, Contract 68-03-2116, U.S. Environmental Protection Agency, Office of Mobile Source Air Pollution Control February 1977.

8. Williams, Gary N., "Prudhoe Bay", Lab Assay No. A2142, Exxon Research & Engineering Co., Florham Park, N.J., May 1977.

9. Federal Register, Vol. 42, No. 124, Tuesday, June 28, 1977.

10. Federal Register, Vol. 40, No. 126, June 30, 1975. Subparts I & J.

11. Springer, Karl J., and Baines, Thomas M., "Emissions from Diesel Versions of Production Passenger Cars." SAE Paper No. 770818, Detroit, Michigan, September 1977.

12. Federal Register, Vol. 45, No. 45, Wednesday, March 5, 1980.

13. Levins, P. L., and Kendall, D. A., "Application of Odor Technology to Mobile Source Emission Instrumentation." CRC Project CAPE 7-68 under Contract No. 68-03-0561, September 1973.

14. Swarin, Stephen J., and Williams, Ronald L., "Liquid Chromatographic Determination of Benzo(a)pyrene in Diesel Exhaust Particulate: Verification of the Collection and Analytical Methods", Research Publication GMR-3127, General Motors Research Laboratories, Warren, Michigan, October 23, 1979.

15. Nie, Norman H., Hull, C. Hadlai, Jenkins, Jean G., Steinbrenner, Karin, and Bent, Dale H., "SPSS", McGraw-Hill, New York, New York, 1975.

16. Health Sciences Computing Facility, "BMDP Biomedical Computer Programs, P-Series 1979", University of California Press, Los Angeles, California, 1979.

APPENDIX A

Contract 68-03-2707

SCOPE OF WORK

Exhibit A

Scope of Work

Objective: The objective of this work is to investigate the influence of fuel characteristics on the emissions of various pollutants from diesel engines.

Plan to achieve objective: The plan to meet this objective shall consist of a systematic study of diesel fuel characteristics and how these characteristics affect diesel emissions. The general orientation of this work will be towards those fuels and fuel composition variables that are currently judged to be important in future fuel makeup. Light-duty diesel vehicles will be tested at this time and the results extrapolated to other diesel engines. The validity of these extrapolations will be tested at a later date.

Task 1: Fuel Variable Selection and Acquisition

A list of fuel variables shall be proposed by the contractor for study under this phase of the contract. This list of variables will be used by the Project Officer to select, in conjunction with the Contractor, approximately 18 fuels variables for use in this program.

A. Fuel Variables

The variables of interest can include, but must not be limited to, the following fuel characteristics:

1. Carbon/hydrogen ratio
2. Aromatic level
3. Density
4. Boiling range
5. Boiling point distribution
6. Sulfur level
7. Sulfur form
8. Metals content
9. Diesel fuel - ethanol blends
10. Diesel fuel - water emulsions
11. Cetane number
12. Residue level (steam jet gum)
13. Presence of a standard additive package (such as pour point depressant, cloudiness eliminator, etc.)
14. Nitrogen content

The fuel variables listed may include: 1) various levels of a given fuel characteristic and 2) where appropriate, a combination of nominally independent fuel characteristics. The variables selected will represent an optimization for the following three objectives: 1) particulate emission rate, 2) soluble organics emission rate, and 3) bioassay (McCann/Ames) activity results.

B. Data Sources

The contractor shall use as input to the fuel variable list, studies which discuss the expected makeup of future fuels. Also, full utilization should be made of the preliminary data concerning the influence of fuel variables on diesel emissions that has been developed at Southwest Research Institute under EPA Contracts #68-02-1777 and #68-03-244C. Such utilization should include appropriate use of the computer-stored and manipulated data from these contracts. The selection of the candidate fuel variables shall be done with all meaningful statistical considerations being included.

C. Acquisition of Fuels

The contractor shall acquire sufficient quantities of fuel that possesses the fuel characteristics that are selected as fuel variables.

Task II: Emissions Testing

A. Vehicle Selection

One diesel vehicle shall be tested for emissions as a function of the above selected fuel variables. This vehicle shall be representative of the "average" type of diesel light-duty vehicle expected to be in use in the near-term to medium-term future. Present thought is to use the Mercedes 240D (which would give continuity with work done under EPA Contract #68-03-2440) or the Oldsmobile diesel. The Volkswagen diesel may also be selected. Final vehicle selection will be made by the Project Officer with Contractor input.

B. Test Cycle and Replicates

The test cycles employed shall be:

1. 1975 FTP (modified by running two complete LA-4's) - 3 replicates
2. 85 kph steady state - 2 replicates
3. The first 505 seconds of the LA-4 for smoke emissions data.

C. Emissions For Which Analyses Shall Be Made

1. HC, CO, NOx and CO_2 shall be analyzed using test procedures outlined in the Federal Register pursuant to light-duty diesel vehicle testing. Aldehydes, phenols and individual HC shall also be measured.

2. Particulate

   a. Mass rate of particulate emissions shall be determined under both the transient and steady state test cycles specified above.

   b. Size distribution shall be determined on the FTP cycle for each fuel variable. Series filtration techniques (or equivalent level of effort) should be employed.

   c. Metal content of total particulate shall be determined. The specific metals for which analyses shall be made will be determined by the Project Officer with contractor input. This selection will be made such that continuity is maintained with previous related projects (EPA Contracts #68-02-1777 and 68-03-2440). Selection will also be made such that the appropriate metals are measured in certain experiments, such as experiments using metal-based fuel additives.

3. Organics: A methodology should be employed for the rapid collection of quantities of particulate that are sufficient for organics analyses. The following analyses shall be performed:

   a. Total mass emissions of soluble organics.

   b. Boiling range of soluble organics.

   c. Carbon, hydrogen, nitrogen and sulfur content. Also, selected oxygen content analyses shall be performed.

   d. Polycyclic organic matter (POM) - An indication of the POM emissions shall be made by analyses of the benzo-a-pyrene (BaP) content of the particulate emissions. This will be achieved by obtaining filter samples and sending them to Dr. Robert Jungers, EPA/RTP.

4. Odor: Odor measurements shall be made using the CRC Cape-7 odor measuring instrument. The specific fuel variables over which these measurements are to be made will be determined by the Project Officer, with contractor input. The selection will be based on previous results (Contracts #68-02-1777 and #68-03-2440) as well as considering the variables selected.

5. Smoke: Smoke emissions shall be determined for all fuel variables over the first 505 seconds of the LA-4 driving cycle. The PHS smoke meter shall be employed as well as an in-line smoke meter.

6. Ames Test Samples: The Contractor shall obtain one sample over the FTP for each fuel variable, prepare the sample and send the sample to the designated laboratory performing the Ames test. The exact details of sample preparation will be determined at a later date by the Project Officer. At the present it appears that the sample will have to be extracted and taken to dryness. A total of 50 mg of extracted organic material will probably be needed for each sample. The contractor shall gather the resultant data and include it in the Final Report.

D. System Check-Out

The sampling and analysis systems and procedures shallbe checked out to assure their proper functioning. Also, appropriate check-out procedures shallbe employed to assure minimal influence of uncontrolled variables on the experimental design. This shall include the influence of lubricating oil on resultant emissions data.

APPENDIX B

FUEL ADDITIVE INFORMATION

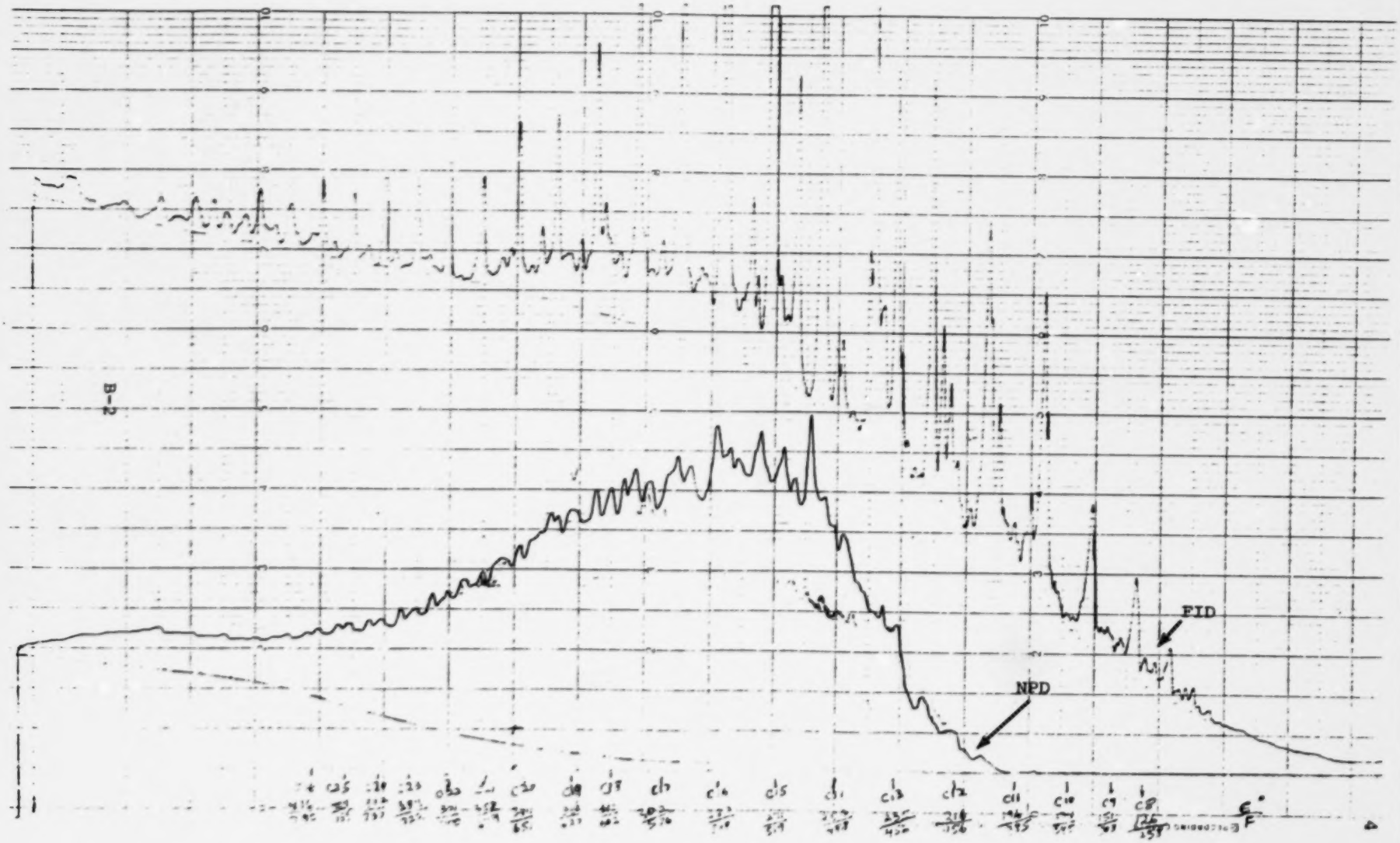

Figure B-1. Chromatogram of Staight Run Shale Oil

EXXON RESEARCH AND ENGINEERING COMPANY

P.O. BOX 51, LINDEN, N.J. 07036

PRODUCTS RESEARCH DIVISION

L.S. BERNSTEIN
Director
Fuels Research Laboratory

July 17, 1979

Components for Diesel
Fuel Research
Ref. No.: 79PR 802

Mr. Charles T. Hare
Dept. of Emissions Research
Southwest Research Institute
P. O. Box 28510
San Antonio, Texas 78284

Dear Mr. Hare:

When you and Mr. Thomas Baines of EPA (Ann Arbor) met with Eric Wigg, Mort Beltzer, and the writer at the Detroit SAE meeting, we agreed to suggest a list of Exxon specialty products (lubricants, chemical feedstocks, solvents, etc.) that you might blend into experimental diesel fuels to vary properties such as cetane number, aromatics, and volatility in order to study systematically the effects of these properties on diesel engine gaseous and particulate emissions.

The list is attached as Table I, with the materials grouped in low-, mid-, and high-aromatic classes and in order of increasing boiling range in each class. The Norpars are almost entirely straight-chain paraffins of C_{11}-C_{12} and C_{13}-C_{14} chain lengths respectively. They should impart high cetane numbers to blends. Isopar M and Telura 705 are made up of highly branched paraffins of relatively lower cetane quality. Telura 705 has a bromine number around 20 cg Br_2/g, indicating a little olefinicity; all other products have little or no olefins. Marcol 52 is intermediate in branching between the Norpars and Isopar M/Telura 705 extremes. Unfortunately, we do not have a high-aromatic product with boiling temperature and viscosity values between those for the last two products in the table. High-boiling aromatics should be handled with precautions against skin contact.

All of these products are presently on allocation, which means that normally they can be supplied only to customers already having contracts for their purchase, and new orders can not be accepted by Exxon Co., U.S.A. However, you may be able to arrange the purchase of so called

"samples" on the order of, say, a barrel or two by calling the Industrial and Consumer Business Sales Office of Exxon Co., U.S.A., at (713) 680-5712 in Houston. For any such samples, you will be specifically advised by letter that providing them does not constitute an offer to sell any additional quantities in the future. Also, some minor variation from listed inspections should be expected.

Please let us know if we can supply further information on these products, or if we can be of any assistance in their procurement. Some properties of blends made from different petroleum products are not easy to predict in advance without using a variety of empirical relationships. We would, therefore, strongly recommend that you prepare trial blends and evaluate their properties before making large blends for engine testing that may fail to meet your blending targets and will exhaust your supplies of components. We would also suggest that you avoid, as being unrealistic, blends of only low- and high-boiling components without an adequate mid-fill component also present.

Very truly yours,

G. P. GROSS
Research Associate

GPG:jk

cc: Messrs. T. M. Baines
T. G. Lipscomb

Attachment

TABLE I

Exxon Specialty Products Potentially Useful for Studying
Diesel Fuel Composition Effects on Engine Emissions

Product Name	Typical[1] Inspections							
	% Aromatics	Gravity, °API	D 86 Distillation, °F					Kin. Visc., cstk at 100°F.
			IBP	10%	50%	90%	FBP	
Norpar 12	<1.5	57.0	370	380	393	412	428	1.4
Norpar 13	<1.5	53.8	443	451	457	471	486	1.9
Isopar M	<2	49.0	394	412	429	470	497	2.4
Telura 705	<2	41.2	511	523	538	569	599	7.6
Marcol 52	<1	38.7	569	593	623	686	>700	7.4
3146 Hydraulic Oil Base	19	36.0	394	444	484	536	578	2.9
Mentor 28	24	36.0	487	528	564	594	602	4.3
Telura 607	16	37.0	570	590	620	685	>700	7.5
Necton 37	16	29.5	590	620	655	704	721	14.4
Exxon HAN (Hvy. Ar. Naphtha)	84	27.1	348	386	435	494	528	1.54
Nuso 38	67	16.3	613	632	662	718	~770	29

(1) Aromatics contents listed may be by MS, silica gel separation, or FIA; FIA is not useful for high-boiling or high-viscosity materials. Some distillation data are converted to estimated ASTM-D 86 results from vacuum or GC distillations. The D 86 is a standardized method, but gives very poor (1-plate) separations; materials boiling below the initial and above the final boiling points are always present and can be better-detected by GC "distillation".

G. P. Gross
July 17, 1979

Chevron Chemical Company
One Crossroads of Commerce – Suite 1000
Rolling Meadows, IL 60008

January 29, 1980

Mr. Bruce Bykowski
Southwest Research Inst.
P.O. Drawer 28510
San Antonio, TX 78284

Dear Bruce:

Enclosed you will find Chevron Alpha Olefin data sheets and current pricing information. I also included some idea sheets which I thought might be of interest to you.

I hope this information can be of some benefit. Please don't hesitate to call if you need any further assistance.

Very truly yours,

Glenn R. Weckerlin
Technical Sales Representative
PETROCHEMICALS DIVISION

GRW/nn

Encl.

100 Years Helping to Create the Future

EXXON PETROLEUM SOLVENTS

	Aniline Point		Kauri-Butanol Number	Flash Point TCC		Distillation					
						IBP		50%		Dry Point	
	°C	°F		°C	°F	°C	°F	°C	°F	°C	°F
Test Method	ASTM D 611		ASTM D 1133	ASTM D 56		(a) ASTM D 86 (b) ASTM D 1078 (c) ASTM D 850					
HEXANE	62	143	31	<-18	<0	65[b]	149	-	-	69	157
HEPTANE	53	127	38	~-8	~18	94[b]	201	96	204	99	210
LAKTANE	33	92	51	~-6	~21	101[b]	214	103	218	106	223
SOLVENT NO. 5	59	139	37	<-18	<0	71[a]	160	103	218	133	272
VM&P NAPHTHA	49	120	40	7	44	118[b]	244	122	252	139	282
VARSOL 1	54	130	37	42	108	156[a]	313	175	347	202	395
VARSOL 3	54	130	38	41	105	154[a]	310	164	327	176	348
VARSOL 18	63	146	32	41	106	156[a]	313	176	348	199	390
LOW ODOR PARAFFIN SOLVENT	76	169	29	66	150	191[a]	375	216	420	244	472[7]
TOLUENE	8.8[5]	47.8[5]	105	~7	~45	110.2[c]	230.4	-	-	111.0	231.8
XYLENE	10.4[5]	50.7[5]	98	27	80	138[c]	280.4	-	-	140.0	284.0
AROMATIC 100	13.4[5]	56.1[5]	91	42	108	155[a]	311	160	320	173	344
AROMATIC 150*	15.4[5]	59.7[5]	92	66	150	183[a]	362	193	380	210	410
HAN*	29[5]	84[5]	78	57[6]	135[6]	171[a]	340	223	434	277[7]	530[7]
ISOPAR C	79	174	27	~-7	~19	98[b]	208	99	211	106	222
ISOPAR E	76	168	29	~7	~45	116[a]	240	121	250	139	283
ISOPAR G	81	177	28	40	104	157[a]	315	164	328	176	348
ISOPAR H	84	184	27	53	127	176[a]	348	182	360	191	375
ISOPAR K	84	184	27	53	127	177[a]	350	184	363	197	386
ISOPAR L	86	186	27	61	142	188[a]	370	194	382	206	403
ISOPAR M	88	190	27	77[6]	170[6]	207[a]	405	223	434	254	490
NORPAR 12	82	180	23	69[6]	156[6]	188[a]	370	201	393	219	426
NORPAR 13	87	189	22	>79[6]	>175[6]	228[a]	443	236	457	248	479

* Note: All solvents test 30 Saybolt color except HAN (0.5 ASTM) and AROMATIC 150 (+ 27 Saybolt).

(1) Excluding ethylbenzene.

(2) TLV is a registered trademark of the American Conference of Governmental Industrial Hygienists. It is the threshold limit value or occupational exposure limit - the time weighted average concentration for a normal 8-hour workday, 40-hour workweek, to which nearly all workers may be exposed repeatedly without adverse effect. **Refer to the most recent Material Safety Data Sheet for the latest recommended maximum exposure limit for each solvent.**

(3) A TLV has not been established for this product. The value shown has been recommended by Exxon Corporation Medical Research based on consideration of available toxicological

Typical Inspections — The values shown here are representative of current production. Some are controlled by manufacturing specifications, while others are not. All of them may vary within modest ranges.

	Evaporation Rate-Seconds				Rule 102 (formerly 66) Exempt	Composition, Vol%			Sulfur ppm	Bromine Index	Specific Gravity @15.6°C (60°F)	API Gravity	Viscosity cp at 25°C	Inhalation TLV(2) ppm
	25 Vol%	50 Vol%	75 Vol%	95 Vol%		Total Saturates	Total Aromatics	C_9 and Higher(1)						
	Wetlaufer-Gregor (modified)								Microcoulometer	ASTM D 2710	ASTM D 1250	ASTM D 287	ASTM D 445	
	21	45	77	110	Yes	100	0.05	-	1	100	0.682	76.0	0.32	100
	75	150	227	300	Yes	96.0	4.0	-	1	60	0.731	62.0	0.47	400
	102	220	360	540	Yes	82.0	18.0	-	2	60	0.772	51.8	0.54	400(3)
	27	250	475	700	Yes	95.3	4.7	4.4	5	120	0.722	64.6	0.45	400(3)
	196	404	624	856	Yes	87.0	13.0	7.2	5	100	0.759	54.9	0.56	400
	2200	5600	10 900	19 200	No	82.0	18.0	18.0	1	200	0.791	47.5	0.95	100
	1620	3600	6000	9600	No	81.5	18.5	18.5	2	200	0.780	50.0	0.83	200(3)
	2050	4950	9300	14 900	Yes	92.3	7.7	7.5	2	200	0.780	49.9	0.90	200(3)
	-	-	-	-	Yes	97.0	3.0	3.0	2	50	0.790	47.7	2.06(4)	200(3)
	205	428	676	970	No	0.03	99.97	0.02	2	-	0.872	30.8	0.57	100
	590	1200	1895	2580	No	0.1	99.9	75.0	4	-	0.870	31.2	0.62	100
	1620	3600	5650	8500	No	2.8	97.2	97.2	3	-	0.872	30.7	0.78	50(3)
	7200	16 400	28 800	43 200	No	2.6	97.4	97.4	1	-	0.902	25.4	1.20	100(3)
	-	-	-	-	No	20	80	80	0.3(8)	600	0.893	26.9	2.0	100(3)
	69	141	225	295	Yes	100	0.02	-	1	6	0.700	70.8	0.48	400(3)
	162	360	580	835	Yes	100	0.02	-	1	8	0.721	64.7	0.62	400(3)
	1280	2700	4440	6400	Yes	100	0.03	-	1	12	0.750	57.2	1.19(4)	300(3)
	2750	5900	9800	13 800	Yes	100	0.04	-	1	20	0.760	54.6	1.58(4)	300(3)
	2900	6200	10 500	15 200	Yes	100	0.03	-	1	20	0.761	54.5	1.41(4)	300(3)
	5400	12 000	20 100	28 600	Yes	99.9	0.06	-	1	8	0.767	53.0	1.99(4)	300(3)
	10 800	32 400	-	-	Yes	99.7	0.3	-	1	150	0.783	49.2	2.46	300(3)
	9600	22 800	-	-	Yes	99.4	0.6	-	<1	-	0.751	57.0	1.26	300(3)
	-	-	-	-	Yes	99.3	0.7	-	<1	-	0.764	53.8	1.84	300(3)

data. Additional data are being obtained to help define a recommended occupational exposure limit more conclusively.

(4) Viscosity, cp @ 15.5C.

(5) Mixed aniline point.

(6) Pensky-Martens method, ASTM D 93.

(7) Final Boiling Point.

(8) Mass %.

Chevron Chemical Company
Petrochemical Division
Industrial Chemicals
575 Market Street, San Francisco, CA 94105

Technical Data Sheet

CHEVRON ALPHA OLEFIN C15-C18

CHEVRON ALPHA OLEFINS have a highly reactive double bond in the alpha position of long straight chains. They contain both odd and even number carbon atoms which alter their properties and differentiate them from olefins obtained from fats or ethylene polymerization. These ALPHA OLEFINS are now available in twelve versatile fractions.

$CH_3 \cdot (CH_2)_n \cdot CH = CH_2$

alpha olefin

where n varies from 3 to 17

The C_{15}-C_{18} ALPHA OLEFIN fraction is used in the production of surfactants, particularly AOS, as a partial sperm oil substitute for leather treating, in metal working and gear oil additives, as a synthetic rosin substitute, and in epoxidation reactions. Other possible applications include specialty chemicals, polymers, resins, and various chemical intermediates.

Chevron's manufacturing control specifications and typical tests are:

			Specifications*		
	Test Method		Minimum	Maximum	Typical Tests*
Condition at 70°F	SM 60-15		Clear and Bright, Free of Sediment		
Color, Saybolt	ASTM D-156		-5	–	7
Paraffin Content, Wt. %	SM 100-25		–	3	2
Diolefin Content, Wt. %	SM 100-25		–	6	6
Straight Chain Mono Alpha Olefins, Wt. %	SM 100-25		87	–	89
Peroxide Content, meq/l	SM 80-16		–	5	1
Sulfur Content, ppm	SM 205-27		–	20	15
Carbon No. Distribution, Wt. %	SM 100-25	C_{14}		5	2
		C_{15}	26		30
		C_{16}	25		30
		C_{17}	23		28
		C_{18}	8	12	10
		C_{19}		3	0.1
Average Molecular Wt.	SM 100-25		226	231	226
Distillation at 760 mm Hg, °F	ASTM D-86				
Start					508
5%					523
95%					558
End Point					584
Density at 20°C, g/ml	ASTM D-941				0.789
Density at 60°F, lbs/gal	–				6.59
Flash Point, TOC, °F	ASTM D-1310				260

*Subject to change without notice.

CHEVRON ALPHA OLEFIN C_{15}-C_{18} is shipped in drums, tank trucks, tank cars and ocean-going vessels. All bulk movements are inhibited with 25 ppm ditertiary butyl paracresol unless specified otherwise by customer.

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C-IM 404-10-OC

Chevron Chemical Company
Petrochemical Division
Industrial Chemicals
575 Market Street, San Francisco, CA 94105

Technical Data Sheet

CHEVRON ALPHA OLEFIN C15-C20

CHEVRON ALPHA OLEFINS have a highly reactive double bond in the alpha position of long straight chains. They contain both odd and even number carbon atoms which alter their properties and differentiate them from olefins obtained from fats or ethylene polymerization. These ALPHA OLEFINS are now available in twelve versatile fractions.

$CH_3 \cdot (CH_2)_n \cdot CH = CH_2$

alpha olefin

where n varies from 3 to 17

The C_{15}-C_{20} ALPHA OLEFIN fraction is used in the production of gasoline additives and high molecular weight sulfonates, alkenyl succinic anhydride (ASA), metal working and gear oil additives, synthetic heavy alkylate, and as a synthetic rosin substitute. Other possible applications include polymers and various chemical intermediates.

Chevron's manufacturing control specifications and typical tests are:

			Specifications*		
	Test Method		Minimum	Maximum	Typical Tests*
Condition at 70°F	SM 60-15		Clear and Bright, Free of Sediment		
Color, Saybolt	ASTM D-156		-16	–	-12
Paraffin Content, Wt. %	SM 100-25		–	6	5
Diolefin Content, Wt. %	SM 100-25		–	6	5
Straight Chain Mono Alpha Olefins, Wt. %	SM 100-25		87	–	88
Peroxide Content, meq/l	SM 80-16		–	5	1
Carbon No. Distribution, Wt. %	SM 100-25	C_{14}		3	1
		C_{15}		19	17
		C_{16}	15		18
		C_{17}	14		17
		C_{18}	13		17
		C_{19}	12		15
		C_{20}	10		12
		C_{21}		5	3
Average Molecular Wt.	SM 100-25		240	250	244
Distillation at 10 mm Hg, °F	ASTM D-1160				
Start					288
5%					295
95%					367
End Point					406
Density at 20°C, g/ml	ASTM D-941				0.787
Density at 60°F, lbs/gal	–				6.60
Flash Point, TOC, °F	ASTM D-1310				280

*Subject to change without notice.

CHEVRON ALPHA OLEFIN C_{15}-C_{20} is shipped in drums, tank trucks, tank cars and ocean-going vessels. All bulk movements are inhibited with 25 ppm ditertiary butyl paracresol unless specified otherwise by customer.

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Chevron Chemical Company
Petrochemical Division
Industrial Chemicals
575 Market Street, San Francisco, CA 94105

Technical Data Sheet

CHEVRON ALPHA OLEFIN C13-C14

CHEVRON ALPHA OLEFINS have a highly reactive double bond in the alpha position of long straight chains. They contain both odd and even number carbon atoms which alter their properties and differentiate them from olefins obtained from fats or ethylene polymerization. These ALPHA OLEFINS are now available in twelve versatile fractions.

$CH_3 \cdot (CH_2)_n \cdot CH = CH_2$

alpha olefin

where n varies from 3 to 17

The C_{13}-C_{14} ALPHA OLEFIN fraction is used primarily in the production of oxo alcohols for detergent manufacture. Other possible applications include lubricants, alkylbenzene feedstock for detergent manufacture, specialty chemicals, polymers, resins, and various chemical intermediates.

Chevron's manufacturing control specifications and typical tests are:

			Specifications*		
	Test Method		Minimum	Maximum	Typical Tests*
Condition at 70°F	SM 60-15		Clear and Bright, Free of Sediment		
Color, Saybolt	ASTM D-156		8	–	11
Paraffin Content, Wt. %	SM 100-25		–	3	2
Diolefin Content, Wt. %	SM 100-25		–	6	5
Straight Chain Mono Alpha Olefins, Wt. %	SM 100-25		87	–	88
Peroxide Content, meq/l	SM 80-16		–	5	2
Sulfur Content, ppm	SM 205-27		–	20	10
Carbon No. Distribution, Wt. %	SM 100-25	C_{12}		3	2
		C_{13}	40		47
		C_{14}	40		48
		C_{15}		4	3
Average Molecular Wt.	SM 100-25				189
Distillation at 760 mm Hg, °F	ASTM D-86				
Start					420
5%					449
95%					472
End Point					494
Density at 20°C, g/ml	ASTM D-941				0.776
Density at 60°F, lbs/gal	–				6.46
Flash Point, TOC, °F	ASTM D-1310				210

*Subject to change without notice.

CHEVRON ALPHA OLEFIN C_{13}-C_{14} is shipped in drums, tank trucks, tank cars and ocean-going vessels. All bulk movements are inhibited with 25 ppm ditertiary butyl paracresol unless specified otherwise by customer.

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CHM 404 10-OC

Chevron Chemical Company
Petrochemical Division
Industrial Chemicals
575 Market Street, San Francisco, CA 94105

Technical Data Sheet

CHEVRON ALPHA OLEFIN C11-C14

CHEVRON ALPHA OLEFINS have a highly reactive double bond in the alpha position of long straight chains. They contain both odd and even number carbon atoms which alter their properties and differentiate them from olefins obtained from fats or ethylene polymerization. These ALPHA OLEFINS are now available in twelve versatile fractions.

$CH_3 - (CH_2)_n - CH = CH_2$

alpha olefin

where n varies from 3 to 17

The C_{11}-C_{14} ALPHA OLEFIN fraction is used primarily as alkylbenzene feedstock for detergent manufacture and in gasoline additives. Other possible applications include amine oxides, alkylamines, specialty chemicals, polymers, resins and various chemical intermediates.

Chevron's manufacturing control specifications and typical tests are:

			Specifications*		
	Test Method		Minimum	Maximum	Typical Tests*
Condition at 70°F	SM 60-15		Clear and Bright, Free of Sediment		
Color, Saybolt	ASTM D-156		10	–	14
Paraffin Content, Wt. %	SM 100-25		–	3	2
Diolefin Content, Wt. %	SM 100-25		–	6	5
Straight Chain Mono Alpha Olefins, Wt. %	SM 100-25		87	–	89
Peroxide Content, meq/l	SM 80-16		–	5	1
Sulfur Content, ppm	SM 205-27		–	35	10
Carbon No. Distribution, Wt. %	SM 100-25	C_{10}		4	1
		C_{11}	20		27
		C_{12}	20		24
		C_{13}	20		24
		C_{14}	20		23
		C_{15}		4	1
Average Molecular Wt.	SM 100-25		170	176	174
Distillation at 760 mm Hg, °F	ASTM D-86				
Start					388
5%					398
95%					480
End Point					494
Density at 20°C, g/ml	ASTM D-941				0.770
Density at 60°F, lbs/gal	–				6.42
Flash Point, TOC, °F	ASTM D-1310				162

*Subject to change without notice.

CHEVRON ALPHA OLEFIN C_{11}-C_{14} is shipped in drums, tank trucks, tank cars and ocean-going vessels. All bulk movements are inhibited with 25 ppm ditertiary butyl paracresol unless specified otherwise by customer.

Chevron Chemical Company
Petrochemical Division
Industrial Chemicals
575 Market Street, San Francisco, CA 94105

Technical Data Sheet

CHEVRON ALPHA OLEFIN C11-C12

CHEVRON ALPHA OLEFINS have a highly reactive double bond in the alpha position of long straight chains. They contain both odd and even number carbon atoms which alter their properties and differentiate them from olefins obtained from fats or ethylene polymerization. These ALPHA OLEFINS are now available in twelve versatile fractions.

$CH_3 - (CH_2)_n - CH = CH_2$

alpha olefin

where n varies from 3 to 17

The C_{11}-C_{12} ALPHA OLEFIN fraction is used primarily in the production of oxo alcohols for detergent manufacture. Other possible applications include lubricants, alkylbenzene feedstock for detergent manufacture, specialty chemicals, polymers, resins, and various chemical intermediates.

Chevron's manufacturing control specifications and typical tests are:

			Specifications*		
	Test Method		Minimum	Maximum	Typical Tests*
Condition at 70°F	SM 60-15		Clear and Bright, Free of Sediment		
Color, Saybolt	ASTM D-156		10	–	12
Paraffin Content, Wt. %	SM 100-25		–	3	2
Diolefin Content, Wt. %	SM 100-25		–	6	5
Straight Chain Mono Alpha Olefins, Wt. %	SM 100-25		87	–	88
Peroxide Content, meq/l	SM 80-16		–	5	2
Sulfur Content, ppm	SM 205-27		–	20	10
Carbon No. Distribution, Wt. %	SM 100-25	C_{10}		2	2
		C_{11}	40		51
		C_{12}	40		45
		C_{13}		3	2
Average Molecular Wt.	SM 100-25				161
Distillation at 760 mm Hg, °F	ASTM D-86				
Start					365
5%					385
95%					410
End Point					427
Density at 20°C, g/ml	ASTM D-941				0.762
Density at 60°F, lbs/gal	–				6.35
Flash Point, TOC, °F	ASTM D-1310				160

*Subject to change without notice.

CHEVRON ALPHA OLEFIN C_{11}-C_{12} is shipped in drums, tank trucks, tank cars and ocean-going vessels. All bulk movements are inhibited with 25 ppm ditertiary butyl paracresol unless specified otherwise by customer.

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HYDROCARBON COMPONENT ANALYSIS

PRUDHOE BAY

15/5 CUT POINT	DEG F VT	212 TO 302		YIELD CUT RANGE	VOL %	6.44 TO 13.57		YIELD CUT RANGE	WGT %	4.95 TO 11.13	
15/5 CUT POINT	DEG C VT	100 TO 150		YIELD ON CRUDE	VOL %	7.13		YIELD ON CRUDE	WGT %	6.13	

COMPONENT	VOL %	WGT %	COMPONENT	VOL %	WGT %	COMPOUND	VOL %	WGT %
2,3-DIMETHYLPENTANE	0.14	0.13	2,3-DIMETHYLHEXANE	0.40	0.37	3-ETHYLHEPTANE	0.02	0.01
2,3,3-TRIMETHYLPENTANE	0.01	0.01	2,4-DIMETHYLHEXANE	0.47	0.43	N-OCTANE	0.06	0.05
2,3,4-TRIMETHYLPENTANE	0.16	0.17	2,5-DIMETHYLHEXANE	0.32	0.29	2-METHYLOCTANE	0.72	0.74
3-ETHYLPENTANE	0.04	0.04	3,3-DIMETHYLHEXANE	0.09	0.08	3-METHYLOCTANE	0.21	0.21
2-METHYL,3-ETHYLPENTANE	0.21	0.20	3,4-DIMETHYLHEXANE	0.24	0.23	4-METHYLOCTANE	1.31	1.34
METHYLCYCLOPENTANE	0.05	0.05	ETHYLHEXANE	0.11	0.10	N-NONANE	0.21	0.22
1,CIS-2-DIMETHYLCYCLOPENTANE	0.40	0.41	CYCLOHEXANE	0.20	0.20	C9 PARAFFINS	0.04	0.04
1,CIS-3-DIMETHYLCYCLOPENTANE	0.21	0.21	METHYLCYCLOHEXANE	8.72	8.79			
1,TRANS-2-DIMETHYLCYCLOPENTANE	0.49	0.48	1,CIS-2-DIMETHYLCYCLOHEXANE	1.57	1.64	C9 NAPHTHENES	0.05	0.05
1,TRANS-3-DIMETHYLCYCLOPENTANE	0.19	0.19	1,CIS-3-DIMETHYLCYCLOHEXANE	1.06	1.08	C10 NAPHTHENES	0.04	0.04
1,1,2-TRIMETHYLCYCLOPENTANE	0.25	0.25	1,CIS-4-DIMETHYLCYCLOHEXANE	0.72	0.74	BENZENE	0.03	0.03
1,1,3-TRIMETHYLCYCLOPENTANE	0.24	0.24	1,TRANS-2-DIMETHYLCYCLOHEXANE	2.16	2.20	ETHYLBENZENE	0.18	0.18
1,T2,C3-TRIMETHYLCYCLOPENTANE	1.01	1.00	1,TRANS-4-DIMETHYLCYCLOHEXANE	4.15	4.15	ISOPROPYLBENZENE	0.36	0.36
1,T2,C4-TRIMETHYLCYCLOPENTANE	0.74	0.73	ETHYLCYCLOHEXANE	3.42	3.53	N-PROPYLBENZENE	0.33	0.33
ETHYLCYCLOPENTANE	1.04	1.05	TRIMETHYLCYCLOHEXANES	3.13	3.13	1-METHYL,2-ETHYLBENZENE	0.02	0.02
METHYL, ETHYLCYCLOPENTANES	1.06	1.08	N-HEPTANE	4.36	3.93	1-METHYL,3-ETHYLBENZENE	0.19	0.21
1,C2,C4-TRIMETHYLCYCLOPENTANE	0.25	0.25	2-METHYLHEPTANE	3.57	3.27	1-METHYL,4-ETHYLBENZENE	0.06	0.06
N-HEXANE	0.05	0.04	3-METHYLHEPTANE	2.59	2.41	TOLUENE	7.91	9.06
2-METHYLHEXANE	0.25	0.22	4-METHYLHEPTANE	1.07	0.99	ORTHOXYLENE	0.12	0.13
3-METHYLHEXANE	0.48	0.43	2,4-DIMETHYLHEPTANE	0.38	0.36	PARAXYLENE	1.50	1.69
2,2-DIMETHYLHEXANE	0.02	0.02	2,6-DIMETHYLHEPTANE	1.51	1.40	METAXYLENE	5.79	6.61

VOL % OF 212/302	C5	C6	C7	C8	C9	C10	C11	TOTAL
N-PARAFFINS		.05	4.38	9.26	6.11			19.80
ISOPARAFFINS			.91	9.33	7.92			18.15
TOTAL PARAFFINS		.05	5.30	18.58	14.03			37.96
CYCLOPENTANES		.05	2.34	4.36				6.75
CYCLOHEXANES		.20	8.72	13.11	9.97	2.09		34.08
TOTAL NAPHTHENES		.25	11.06	17.47	9.97	2.09		40.83
AROMATICS		.03	7.97	12.25	.96			21.21
TOTAL		.32	24.33	48.30	24.97	2.09		100.00

WGT % OF 212/302	C5	C6	C7	C8	C9	C10	C11	TOTAL
N-PARAFFINS		.04	3.93	8.54	5.75			18.26
ISOPARAFFINS			.82	8.60	7.43			16.85
TOTAL PARAFFINS		.04	4.75	17.14	13.18			35.11
CYCLOPENTANES		.05	2.34	4.35				6.74
CYCLOHEXANES		.20	8.79	13.34	9.69	2.02		34.04
TOTAL NAPHTHENES		.25	11.13	17.69	9.69	2.02		40.78
AROMATICS		.03	9.06	13.93	1.09			24.11
TOTAL		.32	24.94	48.76	23.96	2.02		100.00

APPENDIX C

TEST PLAN AND DATA REDUCTION INFORMATION

85 KM/H Cruise Conditions

1. Before beginning a days run, set room air to 68°F.
2. CVS heater box should be off.
3. Run 15 minutes after last FTP.
4. Start vehicle and sampling systems. Start roll counter.
5. Accelerate to and hold vehicle to 85 km/h cruise condition for 10 minutes.
6. At 10 minute mark, stop sampling. Stop roll counter.
7. After sampling has stopped, stop vehicle and shut-off engine.
8. Soak for 10 minutes.
9. Start vehicle and bring vehicle to 85 km/h.
10. Begin additional 10 minutes of sampling. Start roll counter.
11. Stop sampling. Stop roll counter.
12. Stop vehicle. Test Complete.
13. After test, reset room air temperature.

FTP VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 443-A RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO. 1
DATE 8/14/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-443-F
ODOMETER 14471. KM(8992. MILES)

BAROMETER 740.16 MM HG(29.14 IN HG)
RELATIVE HUMIDITY 44. PCT
BAG RESULTS

DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)
ABS. HUMIDITY 12.1 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.05

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H20(IN. H20)	422.3 (24.5)	422.3 (24.5)	422.3 (24.5)	422.3 (24.5)
BLOWER INLET P MM. H20(IN. H20)	482.4 (19.0)	482.4 (19.0)	482.4 (19.0)	482.4 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	38.3 (101.0)	37.2 (99.0)	37.5 (99.0)	36.9 (98.0)
BLOWER REVOLUTIONS	12771.	21975.	12795.	21944.
TOT FLOW STD. CU. METRES(SCF)	135.1 (4814.)	215.9 (7619.)	135.4 (4835.)	214.0 (7625.)
HC SAMPLE METER/RANGE/PPM	14.6/11/ 15.	10.5/11/ 11.	10.8/11/ 11.	9.9/11/ 10.
HC BCKGRD METER/RANGE/PPM	4.2/ 1/ 4.	3.2/ 1/ 3.	3.2/ 1/ 3.	3.2/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	29.4/13/ 24.	20.8/13/ 19.	25.4/13/ 23.	22.0/13/ 20.
CO BCKGRD METER/RANGE/PPM	.4/13/ 1.	.4/13/ 0.	.7/13/ 0.	.4/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	42.7/ 3/ .39	24.4/ 3/ .44	39.2/ 3/ .44	27.1/ 3/ .44
CO2 BCKGRD METER/RANGE/PCT	3.8/ 3/ .04	3.0/ 3/ .05	3.8/ 3/ .04	2.8/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	24.4/ 2/ 24.	15.4/ 2/ 15.	24.2/ 2/ 24.	14.4/ 2/ 14.
NOX BCKGRD METER/RANGE/PPM	.7/ 2/ 1.	.7/ 2/ 1.	.7/ 2/ 1.	.9/ 2/ 1.
DILUTION FACTOR	18.49	30.57	20.49	29.96
HC CONCENTRATION PPM	11.	7.	8.	7.
CO CONCENTRATION PPM	24.	19.	22.	19.
CO2 CONCENTRATION PCT	.48	.39	.40	.40
NOX CONCENTRATION PPM	23.7	14.7	22.5	15.5
HC MASS GRAMS	.77	.82	.54	.85
CO MASS GRAMS	3.53	4.43	3.21	4.44
CO2 MASS GRAMS	1557.5	1545.2	1394.9	1587.2
NOX MASS GRAMS	5.05	4.37	5.03	4.72
HC GRAMS/KM	.13	.15	.09	.13
CO GRAMS/KM	.61	.71	.54	.73
CO2 GRAMS/KM	267.4	244.4	235.0	244.9
NOX GRAMS/KM	1.02	1.02	1.01	1.05
FUEL CONSUMPTION BY CB L/100KM	10.30	9.50	9.04	9.52
RUN TIME SECONDS	504.	848.	505.	848.
MEASURED DISTANCE KM	5.02	4.27	5.00	4.43
DEC. WET (DRY)	.959 (.978)		.941 (.941)	
SCF. WET (DRY)	1.000 (.974)		1.000 (.974)	
UOL (SCM)	340.8		341.6	
SAM PLR (SCM)	77.40		77.37	
KM (MEASURED)	12.09		12.32	
FUEL CONSUMPTION L/100KM	9.80		9.29	

COMPOSITE RESULTS

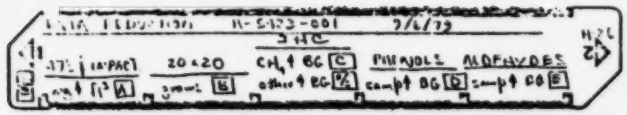
TEST NUMBER		443-A
BAROMETER	MM HG	740.2
HUMIDITY	G/KG	12.1
TEMPERATURE	DEG C	23.3

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	247.4	(247.8)
FUEL CONSUMPTION	L/100KM	9.54	(9.55)
HYDROCARBONS (THC)	G/KM	.13	(.13)
CARBON MONOXIDE	G/KM	.44	(.45)
OXIDES OF NITROGEN	G/KM	1.01	(1.02)

DATA REDUCTION H-5423-001 7/6/79

IHC

47 ↓ IMPACT	20×20	CH_4 ↑ BG [C]	PHENOLS	ALDEHYDES	
mg ↑ ft³ [A]	grams [B]	other ↑ BG [N/A]	samp ↑ BG [D]	samp ↑ BG [E]	



STEP	INSTRUCTIONS	INPUT DATA UNITS	KEYS		OUTPUT DATA/UNITS
	LOAD PROGRAM				
	FUEL DENSITY	g/mL or kg/l	STO	A	
	T_{DSM}	°F	STO	B	
	P_a	in Hg	STO	C	
	FUEL CONSUMPTION	l/100 km	STO	D	
	(RUN) TIME	sec	STO	E	
	(CYCLE) DISTANCE	km	STO	9	
	DFC, wet	——	STO	8	
	DFC, dry	——	STO	7	
	SCF, dry	——	STO	6	
	CVS VOLUME = (VOL − VSAM − SAMEXT)	m³	STO	5	
	VSAM	m³	STO	4	
	SAMEXT	m³	STO	3	
1	ENTER wt. collected by 47 mm filter No. 1	mg	↑		
*2	ENTER volume measured by DSM for filter 1	ft³	A		mg/km, g/kg fuel, and g/hour
3	REPEAT steps 1 & 2 for n = 2→4 and IMPACTOR*				
4	ENTER wt. collected by 20×20 filter *	grams	B		mg/km, g/kg fuel, and g/hour
5	ENTER CH_4 sample concentration	ppmC	↑		
6	ENTER CH_4 background concentration	ppmC	C		mg/km, g/kg fuel, and g/hour
7	ENTER next IHC sample concentration (IN ORDER)	ppmC	↑		
8	ENTER corresponding background concentration	ppmC	R/S		mg/km, g/kg fuel, and g/hour
9	REPEAT steps 7 & 8 for each IHC (IN ORDER)				
10	ENTER phenol compound sample concentration	μg/m³	↑		
11	ENTER corresponding background concentration	μg/m³	D		mg/km, g/kg fuel, and g/hour
12	REPEAT steps 10 & 11 for all phenol compounds				
13	ENTER aldehyde sample concentration	μg/m³	↑		
14	ENTER corresponding background concentration	μg/m³	E		mg/km, g/kg fuel, and g/hour
15	REPEAT steps 13 & 14 for all aldehydes				
16	FOR NEW RUN, ENTER DATA (STORAGE				
	REGISTERS A-E, 9-3) AND PROCEED				
	TO STEP 1				
*	Note: RCL 0 after step 2 for dilute μg/m³				
	RCL 1 after step 2 for μg/test				
#	FOR IMPACTOR DENSITY 4-BAG FUEL CONSUMPTION,				
	AVER. TIME, DIS. ETC. OF PTOR SYSTEM				

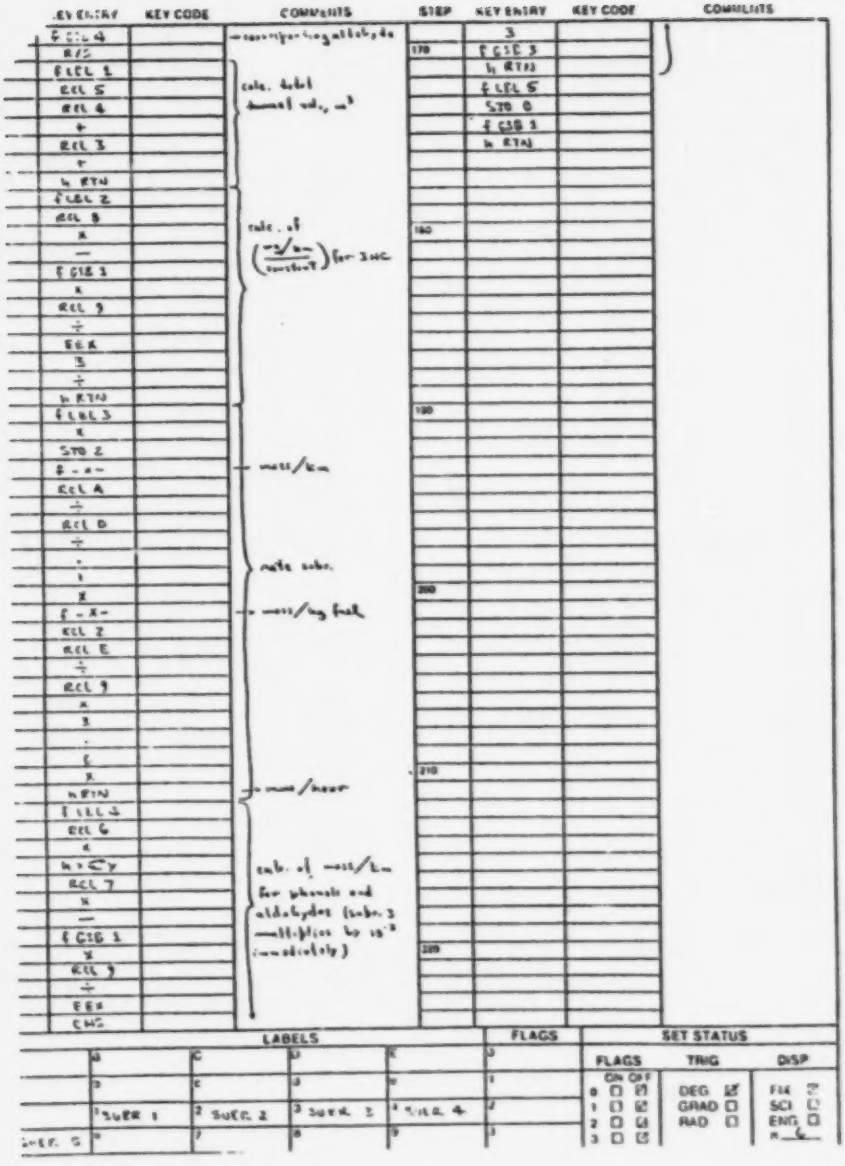
[illegible]

STEP	KEY ENTRY	KEY CODE	COMMENTS
	[illegible]		
	[illegible]		
	÷		
	[illegible]		
	[illegible]		
	.		
	[illegible]		
	x		
010	RCL B		
	4		
	6		
	0		
	1		
	.		
	RCL C		
	÷		
	f GSB 5		
	x		
020	STO 1		
	RCL 9		
	÷		
	EEX		
	CHS		
	3		
	f GSB 3		
	R/S		
	f LBL 2		
	RCL 4		
030	÷		
	f GSB 1		
	x		
	STO 1		
	RCL 9		
	÷		
	EEX		
	3		
	f GSB 3		
	R/S		
040	f LBL C		← CH_4
	f GSB 2		
	6		
	6		
	6		
	f GSB 3		→ CH_4
	R/S		← C_2H_6
	f GSB 2		
	5		
	8		
050	2		
	.		
	7		
	f GSB 3		→ C_2H_6
	R/S		← C_2H_4
	f GSB 2		
	6		
	2		
	4		
	.		
060	4		
	f GSB 3		→ C_2H_4
	R/S		← C_2H_2
	f GSB 2		
	5		
	4		
	1		
	.		
	4		
	f GSB 3		→ C_2H_2
070	R/S		← C_3H_8
	f GSB 2		
	6		
	1		
	0		
	.		
	6		
	f GSB 3		→ C_3H_8
	R/S		← C_3H_6
	f GSB 2		
080	5		
	8		
	2		
	.		
	7		
	f GSB 3		→ C_3H_6
	R/S		← C_4H_6
	f GSB 2		
	5		
	4		
090	1		
	.		
	4		
	f GSB 3		→ C_4H_6
	R/S		← C_4H_8
	f GSB 2		
	5		
	4		
	7		
	f GSB 3		→ C_4H_8
100	R/S		
	f LBL D		← any phenol
	EEX		
	3		
	x		
	x⇄y		
	EEX		
	3		
	x		
	f GSB 4		→ corresponding phenol
110	R/S		
	f LBL E		← any aldehyde
	x⇄y		

REGISTERS

0 USED	1 USED	2 USED	3 SAMPLAT m^3	4 VSAM m^3	5 VOL exh m^3	6 SCF dry	7 DFC dry	8 DFC wet	9 DISTANCE km
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A [illegible] DENSITY [illegible] kg/l	B T_{OBS}, °F	C P_B, in Hg	D FUEL CONS. L/100 km	E (Fuel) TIME, sec	I



KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
f GSB 4		— corresponding aldehyde		3		
R/S			170	f GSB 3		
f LBL 1				h RTN		
RCL 5		calc. total		f LBL 5		
RCL 4		[illegible] vol., m^3		STO 0		
+				f GSB 1		
RCL 3				h RTN		
+						
h RTN						
f LBL 2						
RCL 8		calc. of				
×		$\left(\frac{mg/km}{constant}\right)$ for 3HC	180			
—						
f GSB 1						
×						
RCL 9						
÷						
EEX						
3						
÷						
h RTN						
f LBL 3			190			
×						
STO 2						
f -x-		— mass/km				
RCL A						
÷						
RCL D						
÷						
.						
1		rate subs.				
×			200			
f -x-		— mass/kg fuel				
RCL 2						
RCL E						
÷						
RCL 9						
×						
3						
.						
6						
×			210			
h RTN		— mass/hour				
f LBL 4						
RCL 6						
×						
h → Cy		calc. of mass/km				
RCL 7		for phenols and				
×		aldehydes (subs. 3				
—		multiplies by 10^{-3}				
f GSB 1		immediately)				
×			220			
RCL 9						
÷						
EEX						
CHS						

LABELS					FLAGS
	B	C	D	E	0
	D	E	F	G	1
	1 SUBR 1	2 SUBR 2	3 SUBR 3	4 SUBR 4	2
SUBR 5	6	7	8	9	3

SET STATUS		
FLAGS	TRIG	DISP
ON OFF		
0 ☐ ☑	DEG ☑	FIX ☐
1 ☐ ☑	GRAD ☐	SCI ☐
2 ☐ ☑	RAD ☐	ENG ☐
3 ☐ ☑		6

DATA REDUCTION 11-5423-001

DATE 8/14/80	TEST No. 463-A	SCHEDULE FTP$_C$	FUEL EM-463-F	FUEL dens. 0.825 g/ml
DRIVER L. Pool	TUNNEL OPR. LM	SAMPLING OPR. T. Jack		T_{DGM} 74 °F

FROM COMPUTER OUTPUT

Pa 29.14 in Hg	FUEL CONS. 9.89 l/100km	TIME 1372 sec	DISTANCE 12.09 km	DFC wet .959
DFC dry .939	SCF dry .974	(CVS) VOL 260.1 std. m³	(20x20) VSAM 77.40 std m³	
			SAMEXT 3.23 std m³	

IMPACTOR AND FILTER DATA

COLLECTED WT., mg (except 20x20)					PARTICULATE MASS RATE		
SET	BY DISC No.	47mm FILTERS (code)		FLOW, ft³	mg/km	g/kg fuel	g/h
3	7	1 (F47-26)	2.886	20.2[illegible]3	147.059	1.802	4.665
4	8	2 (G47-31)	6.450	22.350	298.139	3.655	9.459
5	9	3 (P47-31)	7.012	25.708	281.903	3.455	8.943
6	10	4 (S47-30)	2.612	9.470	285.069	3.494	9.043
IMPACTOR FILTER	code (IP47-10) wt. mg	IMP. Σ mg					
20x20 FILTER No. P47-38	wt. (grams)	0.7675		—	279.461	3.425	8.865

UNREGULATED EMISSIONS

INDIVIDUAL HYDROCARBONS						Filtered/unfiltered PHENOLS				
(ppmC)	sample	backg'nd.	mg/km	g/kg fuel	g/h	(µg/m³)	sample/backg'nd.	µg/km	mg/kg fuel	mg/h
CH_4	2.470	2.131	8.003	0.098	0.254	phenol	0/0			
C_2H_4	1.31	0	21.513	0.264	0.682	salicylaldehyde	0/0			
C_2H_6	1.04	0	0.704	0.009	0.022	m-cresol + p-cresol	0/0			
C_2H_2	0.23	0	3.509	0.043	0.111	p-ethylphenol + 2-isopropyl phenol + 2,3-xylenol + 3,5-xylenol + 2,4,6-trimethyl phenol	15/0	411.95/0	5.05/0	13.06/0
C_3H_8	0	0	0	0	0					
C_3H_6	0.411	0	6.749	0.083	0.214	2,3,5-trimethyl phenol	0/0	0	0	0
C_6H_6	0	0	0	0	0	2,3,5,6-tetramethyl phenol	0/0	0	0	0
C_7H_8	0.26	0	4.008	0.049	0.127	2-n-propyl-phenol	0/0	0	0	0

Note: includes

ALDEHYDES					
(µg/m³)	sample	background	mg/km	g/kg fuel	g/h
formaldehyde	[illegible]	[illegible]	0	0	0
acetaldehyde	0	0	0	0	0
acetone +	0	0	0	0	0
isobutyrald.	0	0	0	0	0
crotonald	34.16	0	0.938	0.011	0.030
hexanal	0	0	0	0	0
benzaldehyde	[illegible]	[illegible]	12[illegible].[illegible]79	1.590	4.115

Note: "acetone" includes acrolein & propanal

APPENDIX D

GASEOUS EMISSIONS DATA

FTP VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 395-A RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 10/17/79
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-395-F
ODOMETER 12603. KM(7831. MILES)

BAROMETER 742.44 MM HG(29.23 IN HG)
RELATIVE HUMIDITY 51. PCT

DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)
ABS. HUMIDITY 9.7 GM/KG

NOX HUMIDITY CORRECTION FACTOR .97

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	COLD TRANSIENT	STABILIZED	HOT TRANSIENT	STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	635.0 (25.0)	635.0 (25.0)	635.0 (25.0)	635.0 (25.0)
BLOWER INLET P MM. H2O(IN. H2O)	495.3 (19.5)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)
BLOWER REVOLUTIONS	12524.	21530.	12540.	21515.
TOT FLOW STD. CU. METRES(SCF)	121.6 (4294.)	209.3 (7390.)	121.7 (4299.)	208.9 (7376.)
HC SAMPLE METER/RANGE/PPM	10.9/11/ 11.	8.1/11/ 8.	10.3/11/ 10.	8.7/11/ 9.
HC BCKGRD METER/RANGE/PPM	3.8/ 1/ 4.	3.8/ 1/ 4.	2.5/ 1/ 3.	2.5/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	26.4/13/ 24.	18.7/13/ 17.	25.4/13/ 23.	21.3/13/ 19.
CO BCKGRD METER/RANGE/PPM	1.1/13/ 1.	.9/13/ 1.	3.1/13/ 3.	3.1/13/ 3.
CO2 SAMPLE METER/RANGE/PCT	40.5/ 3/ .69	25.3/ 3/ .41	35.4/ 3/ .59	25.3/ 3/ .41
CO2 BCKGRD METER/RANGE/PCT	2.8/ 3/ .04	2.9/ 3/ .04	2.9/ 3/ .04	2.7/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	17.9/ 2/ 18.	11.5/ 2/ 12.	16.7/ 2/ 17.	11.6/ 2/ 12.
NOX BCKGRD METER/RANGE/PPM	.7/ 2/ 1.	.6/ 2/ 1.	.6/ 2/ 1.	.7/ 2/ 1.
DILUTION FACTOR	19.41	32.27	22.47	32.25
HC CONCENTRATION PPM	7.	4.	8.	6.
CO CONCENTRATION PPM	22.	15.	20.	16.
CO2 CONCENTRATION PCT	.65	.37	.55	.37
NOX CONCENTRATION PPM	17.2	10.9	16.1	10.9
HC MASS GRAMS	.51	.53	.56	.75
CO MASS GRAMS	3.13	3.76	2.78	3.88
CO2 MASS GRAMS	1439.2	1417.1	1227.3	1425.8
NOX MASS GRAMS	3.88	4.23	3.63	4.22
HC GRAMS/KM	.09	.09	.10	.12
CO GRAMS/KM	.55	.62	.49	.63
CO2 GRAMS/KM	253.5	232.5	215.9	233.3
NOX GRAMS/KM	.68	.69	.64	.69
FUEL CONSUMPTION BY CB L/100KM	10.30	9.46	8.78	9.49
RUN TIME SECONDS	504.	868.	505.	867.
MEASURED DISTANCE KM	5.68	6.09	5.68	6.11
DFC, WET (DRY)	.761 (.946)		.964 (.948)	
SCF, WET (DRY)	1.000 (.979)		1.000 (.979)	
VOL (SCM)	330.9		330.6	
SAM BLR (SCM)	77.45		77.07	
KM (MEASURED)	11.77		11.80	
FUEL CONSUMPTION L/100KM	9.86		9.15	

COMPOSITE RESULTS

TEST NUMBER		395-A
BAROMETER	MM HG	742.4
HUMIDITY	G/KG	9.7
TEMPERATURE	DEG C	23.9

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	232.3	(232.5)
FUEL CONSUMPTION	L/100KM	9.44	(9.46)
HYDROCARBONS (THC)	G/KM	.09	(.10)
CARBON MONOXIDE	G/KM	.57	(.57)
OXIDES OF NITROGEN	G/KM	.68	(.68)

FTP VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 395-B RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 10/18/79
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-395-F
ODOMETER 12617. KM(7840. MILES)

BAROMETER 742.70 MM HG(29.24 IN HG)
RELATIVE HUMIDITY 58. PCT
DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)
ABS. HUMIDITY 10.6 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.00

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	622.3 (24.5)	609.6 (24.0)	622.3 (24.5)	622.3 (24.5)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)
BLOWER REVOLUTIONS	12531.	21529.	12567.	21470.
TOT FLOW STD. CU. METRES(SCF)	122.4 (4321.)	210.4 (7429.)	122.4 (4321.)	209.2 (7388.)
HC SAMPLE METER/RANGE/PPM	10.6/11/ 11.	8.0/11/ 8.	9.4/11/ 9.	7.7/11/ 8.
HC BCKGRD METER/RANGE/PPM	2.5/ 1/ 3.	2.5/ 1/ 3.	1.8/ 1/ 2.	1.8/ 1/ 2.
CO SAMPLE METER/RANGE/PPM	25.1/13/ 23.	17.5/13/ 15.	21.7/13/ 19.	17.8/13/ 16.
CO BCKGRD METER/RANGE/PPM	.8/13/ 1.	.8/13/ 1.	.4/13/ 0.	.6/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	40.2/ 3/ .68	25.6/ 3/ .42	34.6/ 3/ .58	24.4/ 3/ .40
CO2 BCKGRD METER/RANGE/PCT	2.8/ 3/ .04	2.6/ 3/ .04	2.5/ 3/ .04	2.3/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	19.6/ 2/ 20.	12.5/ 2/ 13.	17.4/ 2/ 17.	11.9/ 2/ 12.
NOX BCKGRD METER/RANGE/PPM	1.1/ 2/ 1.	1.0/ 2/ 1.	1.2/ 2/ 1.	1.0/ 2/ 1.
DILUTION FACTOR	19.57	31.88	23.05	33.54
HC CONCENTRATION PPM	8.	6.	8.	6.
CO CONCENTRATION PPM	21.	14.	18.	15.
CO2 CONCENTRATION PCT	.64	.38	.54	.36
NOX CONCENTRATION PPM	18.6	11.5	16.3	10.9
HC MASS GRAMS	.58	.67	.54	.71
CO MASS GRAMS	3.01	3.53	2.63	3.62
CO2 MASS GRAMS	1435.8	1462.0	1214.2	1390.9
NOX MASS GRAMS	4.33	4.63	3.79	4.36
HC GRAMS/KM	.10	.11	.10	.12
CO GRAMS/KM	.53	.58	.46	.59
CO2 GRAMS/KM	250.6	238.3	212.3	226.3
NOX GRAMS/KM	.76	.75	.66	.71
FUEL CONSUMPTION BY CB L/100KM	10.18	9.69	8.63	9.21
RUN TIME SECONDS	504.	867.	507.	868.
MEASURED DISTANCE KM	5.73	6.14	5.72	6.15
DFC, WET (DRY)	.961 (.943)		.965 (.947)	
SCF, WET (DRY)	1.000 (.976)		1.000 (.977)	
VOL (SCM)	332.8		331.6	
SAM BLR (SCM)	79.60		78.55	
KM (MEASURED)	11.86		11.87	
FUEL CONSUMPTION L/100KM	9.93		8.93	

COMPOSITE RESULTS

			3-BAG	(4-BAG)
TEST NUMBER		395-B		
BAROMETER	MM HG	742.7		
HUMIDITY	G/KG	10.6		
TEMPERATURE	DEG C	23.3		
CARBON DIOXIDE	G/KM		233.7	(230.2)
FUEL CONSUMPTION	L/100KM		9.50	(9.36)
HYDROCARBONS (THC)	G/KM		.10	(.11)
CARBON MONOXIDE	G/KM		.53	(.54)
OXIDES OF NITROGEN	G/KM		.73	(.72)

85KM/H VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 359-B RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 10/18/79
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-395-F
ODOMETER 12695. KM(7888. MILES)

BAROMETER 742.70 MM HG(29.24 IN HG)
RELATIVE HUMIDITY 54. PCT

DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)
ABS. HUMIDITY 9.9 GM/KG

NOX HUMIDITY CORRECTION FACTOR .98

BAG RESULTS

TEST CYCLE		85KM
BLOWER DIF P MM. H2O(IN. H2O)		609.6 (24.0)
BLOWER INLET P MM. H2O(IN. H2O)		482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)		43.3 (110.0)
BLOWER REVOLUTIONS		29777.
TOT FLOW STD. CU. METRES(SCF)		289.8 (10235.)
HC SAMPLE METER/RANGE/PPM		16.8/11/ 17.
HC BCKGRD METER/RANGE/PPM		1.8/ 1/ 2.
CO SAMPLE METER/RANGE/PPM		35.7/13/ 33.
CO BCKGRD METER/RANGE/PPM		1.1/13/ 1.
CO2 SAMPLE METER/RANGE/PCT		57.4/ 3/ 1.01
CO2 BCKGRD METER/RANGE/PCT		3.0/ 3/ .05
NOX SAMPLE METER/RANGE/PPM		38.9/ 2/ 39.
NOX BCKGRD METER/RANGE/PPM		1.4/ 2/ 1.
DILUTION FACTOR		13.19
HC CONCENTRATION PPM		15.
CO CONCENTRATION PPM		31.
CO2 CONCENTRATION PCT		.97
NOX CONCENTRATION PPM		37.6
HC MASS GRAMS		2.53
CO MASS GRAMS		10.32
CO2 MASS GRAMS		5142.4
NOX MASS GRAMS		20.33
RUN TIME	SECONDS	1200.
DFC, WET (DRY)		.924 (.908)
SCF, WET (DRY)		1.000 (.973)
VOL (SCM)		289.8
SAM BLR (SCM)		68.66
KM (MEASURED)		28.17
TEST NUMBER,		359-B
BAROMETER,	MM HG	742.7
HUMIDITY,	G/KG	9.9
TEMPERATURE,	DEG C	23.3
CARBON DIOXIDE,	G/KM	182.5
FUEL CONSUMPTION,	L/100KM	7.42
HYDROCARBONS,	G/KM	.09
CARBON MONOXIDE,	G/KM	.37
OXIDES OF NITROGEN,	G/KM	.72

85KM/H VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 395-B RUN 2
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 10/23/79
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-395-F
ODOMETER 12812. KM(7961. MILES)

BAROMETER 744.98 MM HG(29.33 IN HG)
RELATIVE HUMIDITY 17. PCT

DRY BULB TEMP. 26.1 DEG C(79.0 DEG F)
ABS. HUMIDITY 3.7 GM/KG

NOX HUMIDITY CORRECTION FACTOR .81

BAG RESULTS
TEST CYCLE

	85KM
BLOWER DIF P MM. H2O(IN. H2O)	609.6 (24.0)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	43.3 (110.0)
BLOWER REVOLUTIONS	29776.
TOT FLOW STD. CU. METRES(SCF)	291.2 (10282.)
HC SAMPLE METER/RANGE/PPM	18.4/11/ 18.
HC BCKGRD METLR/RANGE/PPM	2.3/ 1/ 2.
CO SAMPLE METER/RANGE/PPM	39.6/13/ 37.
CO BCKGRD METER/RANGE/PPM	.8/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	58.0/ 3/ 1.02
CO2 BCKGRD METER/RANGE/PCT	2.2/ 3/ .03
NOX SAMPLE METER/RANGE/PPM	45.0/ 2/ 45.
NOX BCKGRD METER/RANGE/PPM	.8/ 2/ 1.
DILUTION FACTOR	13.03
HC CONCENTRATION PPM	16.
CO CONCENTRATION PPM	35.
CO2 CONCENTRATION PCT	.99
NOX CONCENTRATION PPM	44.3
HC MASS GRAMS	2.74
CO MASS GRAMS	11.85
CO2 MASS GRAMS	5290.4
NOX MASS GRAMS	20.03
RUN TIME SECONDS	1199.
DFC, WET (DRY)	.923 (.918)
SCF, WET (DRY)	1.000 (.985)
VOL (SCM)	291.2
SAM BLR (SCM)	68.57
KM (MEASURED)	28.36
TEST NUMBER	395-B
BAROMETER, MM HG	745.0
HUMIDITY, G/KG	3.7
TEMPERATURE, DEG C	26.1
CARBON DIOXIDE, G/KM	186.6
FUEL CONSUMPTION, L/100KM	7.59
HYDROCARBONS, G/KM	.10
CARBON MONOXIDE, G/KM	.42
OXIDES OF NITROGEN, G/KM	.71

FTP VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 404-A RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 10/31/79
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-404-F
ODOMETER 12892. KM(8011. MILES)

BAROMETER 738.89 MM HG(29.09 IN HG)
RELATIVE HUMIDITY 21. PCT
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)
ABS. HUMIDITY 4.3 GM/KG

NOX HUMIDITY CORRECTION FACTOR .82

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	635.0 (25.0)	635.0 (25.0)	635.0 (25.0)	635.0 (25.0)
BLOWER INLET P MM. H2O(IN. H2O)	495.3 (19.5)	495.3 (19.5)	495.3 (19.5)	495.3 (19.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)
BLOWER REVOLUTIONS	12556.	21572.	12564.	21568.
TOT FLOW STD. CU. METRES(SCF)	121.3 (4284.)	208.5 (7361.)	121.4 (4287.)	208.4 (7359.)
HC SAMPLE METER/RANGE/PPM	8.4/11/ 8.	6.2/11/ 6.	7.9/11/ 8.	6.3/11/ 6.
HC BCKGRD METER/RANGE/PPM	1.8/ 1/ 2.	1.8/ 1/ 2.	1.8/ 1/ 2.	1.8/ 1/ 2.
CO SAMPLE METER/RANGE/PPM	23.3/13/ 21.	15.7/13/ 14.	20.9/13/ 19.	15.9/13/ 14.
CO BCKGRD METER/RANGE/PPM	1.7/13/ 1.	1.2/13/ 1.	.8/13/ 1.	.6/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	41.3/ 3/ .70	25.9/ 3/ .42	37.2/ 3/ .63	26.2/ 3/ .43
CO2 BCKGRD METER/RANGE/PCT	3.4/ 3/ .05	3.7/ 3/ .06	3.2/ 3/ .05	3.5/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	22.3/ 2/ 22.	15.1/ 2/ 15.	22.2/ 2/ 22.	16.4/ 2/ 16.
NOX BCKGRD METER/RANGE/PPM	.9/ 2/ 1.	.7/ 2/ 1.	.8/ 2/ 1.	1.4/ 2/ 1.
DILUTION FACTOR	19.01	31.51	21.32	31.12
HC CONCENTRATION PPM	7.	4.	6.	5.
CO CONCENTRATION PPM	19.	13.	18.	13.
CO2 CONCENTRATION PCT	.65	.37	.58	.38
NOX CONCENTRATION PPM	21.4	14.4	21.4	15.0
HC MASS GRAMS	.47	.53	.43	.55
CO MASS GRAMS	2.69	3.07	2.49	3.23
CO2 MASS GRAMS	1449.7	1406.0	1287.6	1437.1
NOX MASS GRAMS	4.10	4.74	4.10	4.95
HC GRAMS/KM	.08	.09	.07	.09
CO GRAMS/KM	.47	.49	.43	.52
CO2 GRAMS/KM	251.1	225.9	221.7	229.7
NOX GRAMS/KM	.71	.76	.71	.79
FUEL CONSUMPTION BY CB L/100KM	10.19	9.17	8.99	9.32
RUN TIME SECONDS	505.	867.	505.	867.
MEASURED DISTANCE KM	5.77	6.22	5.81	6.26
DFC, WET (DRY)	.961 (.954)		.962 (.956)	
SCF, WET (DRY)	1.000 (.988)		1.000 (.989)	
VOL (SCM)	329.8		329.8	
SAM BLR (SCM)	77.22		77.21	
KM (MEASURED)	12.00		12.07	
FUEL CONSUMPTION L/100KM	9.66		9.16	

COMPOSITE RESULTS

TEST NUMBER		404-A
BAROMETER	MM HG	738.9
HUMIDITY	G/KG	4.3
TEMPERATURE	DEG C	25.0

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	229.9	(231.1)
FUEL CONSUMPTION	L/100KM	9.33	(9.38)
HYDROCARBONS (THC)	G/KM	.08	(.08)
CARBON MONOXIDE	G/KM	.47	(.48)
OXIDES OF NITROGEN	G/KM	.74	(.74)

FTP VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 404-E RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 11/13/79
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-404-F
ODOMETER 12991. KM(8072. MILES)

BAROMETER 749.55 MM HG(29.51 IN HG)
RELATIVE HUMIDITY 25. PCT
DRY BULB TEMP. 22.2 DEG C(72.0 DEG F)
ABS. HUMIDITY 4.2 GM/KG

NOX HUMIDITY CORRECTION FACTOR .82

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	622.3 (24.5)	622.3 (24.5)	622.3 (24.5)	622.3 (24.5)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	42.2 (108.0)	43.3 (110.0)	42.2 (108.0)	43.3 (110.0)
BLOWER REVOLUTIONS	12535.	21538.	12541.	22022.
TOT FLOW STD. CU. METRES(SCF)	123.2 (4349.)	211.1 (7454.)	123.2 (4350.)	214.8 (7585.)
HC SAMPLE METER/RANGE/PPM	9.7/11/ 10.	6.4/11/ 6.	8.4/11/ 8.	6.2/11/ 6.
HC BCKGRD METER/RANGE/PPM	3.0/ 1/ 3.	2.8/ 1/ 3.	2.8/ 1/ 3.	2.3/ 1/ 2.
CO SAMPLE METER/RANGE/PPM	22.4/13/ 20.	14.5/13/ 13.	19.7/13/ 18.	14.9/13/ 13.
CO BCKGRD METER/RANGE/PPM	.6/13/ 1.	.5/13/ 0.	.6/13/ 1.	.3/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	41.7/ 3/ .71	25.4/ 3/ .41	36.1/ 3/ .61	25.5/ 3/ .42
CO2 BCKGRD METER/RANGE/PCT	2.8/ 3/ .04	2.4/ 3/ .04	2.8/ 3/ .04	2.6/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	23.7/ 2/ 24.	15.5/ 2/ 16.	22.4/ 2/ 22.	15.9/ 2/ 16.
NOX BCKGRD METER/RANGE/PPM	.3/ 2/ 0.	.6/ 2/ 1.	.7/ 2/ 1.	.9/ 2/ 1.
DILUTION FACTOR	18.81	32.18	22.03	32.04
HC CONCENTRATION PPM	7.	4.	6.	4.
CO CONCENTRATION PPM	19.	12.	17.	13.
CO2 CONCENTRATION PCT	.67	.38	.56	.38
NOX CONCENTRATION PPM	23.4	14.9	21.7	15.0
HC MASS GRAMS	.49	.45	.41	.49
CO MASS GRAMS	2.73	2.99	2.39	3.17
CO2 MASS GRAMS	1508.2	1464.9	1274.3	1485.9
NOX MASS GRAMS	4.54	4.96	4.21	5.08
HC GRAMS/KM	.08	.07	.07	.08
CO GRAMS/KM	.47	.49	.41	.50
CO2 GRAMS/KM	260.9	237.9	221.1	236.0
NOX GRAMS/KM	.79	.80	.73	.81
FUEL CONSUMPTION BY CB L/100KM	10.58	9.65	8.97	9.57
RUN TIME SECONDS	505.	867.	505.	867.
MEASURED DISTANCE KM	5.78	6.16	5.76	6.30
DFC, WET (DRY)	.961 (.953)		.964 (.956)	
SCF, WET (DRY)	1.000 (.987)		1.000 (.987)	
VOL (SCM)		334.3		338.0
SAM BLR (SCM)		78.62		78.60
KM (MEASURED)		11.94		12.06
FUEL CONSUMPTION L/100KM		10.10		9.28

COMPOSITE RESULTS

		404-E
TEST NUMBER		
BAROMETER	MM HG	749.6
HUMIDITY	G/KG	4.2
TEMPERATURE	DEG C	22.2

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	238.0	(237.5)
FUEL CONSUMPTION	L/100KM	9.66	(9.64)
HYDROCARBONS (THC)	G/KM	.08	(.08)
CARBON MONOXIDE	G/KM	.46	(.47)
OXIDES OF NITROGEN	G/KM	.78	(.78)

FTP VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 405-A RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 11/20/79
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-405-F
ODOMETER 13034. KM(8099. MILES)

BAROMETER 740.41 MM HG(29.15 IN HG)
RELATIVE HUMIDITY 74. PCT

DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)
ABS. HUMIDITY 14.7 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.15

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	41.1 (106.0)	41.7 (107.0)	42.2 (108.0)	41.7 (107.0)
BLOWER REVOLUTIONS	12541.	21555.	12546.	21534.
TOT FLOW STD. CU. METRES(SCF)	122.5 (4326.)	210.3 (7426.)	122.2 (4316.)	210.1 (7418.)
HC SAMPLE METER/RANGE/PPM	8.8/11/ 9.	6.5/11/ 6.	8.4/11/ 8.	6.6/11/ 7.
HC BCKGRD METER/RANGE/PPM	2.8/ 1/ 3.	3.7/ 1/ 4.	3.7/ 1/ 4.	2.7/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	23.0/13/ 21.	15.0/13/ 13.	20.1/13/ 18.	15.2/13/ 13.
CO BCKGRD METER/RANGE/PPM	.2/13/ 0.	.2/13/ 0.	.1/13/ 0.	.1/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	41.5/ 3/ .71	26.7/ 3/ .44	38.0/ 3/ .64	26.1/ 3/ .43
CO2 BCKGRD METER/RANGE/PCT	3.0/ 3/ .05	3.4/ 3/ .05	3.6/ 3/ .06	3.5/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	19.6/ 2/ 20.	13.6/ 2/ 14.	18.3/ 2/ 18.	12.5/ 2/ 13.
NOX BCKGRD METER/RANGE/PPM	.7/ 2/ 1.	.9/ 2/ 1.	.5/ 2/ 1.	.7/ 2/ 1.
DILUTION FACTOR	18.91	30.51	20.83	31.25
HC CONCENTRATION PPM	6.	3.	5.	4.
CO CONCENTRATION PPM	20.	13.	17.	13.
CO2 CONCENTRATION PCT	.66	.39	.59	.37
NOX CONCENTRATION PPM	18.9	12.7	17.8	11.8
HC MASS GRAMS	.44	.35	.34	.48
CO MASS GRAMS	2.80	3.09	2.44	3.15
CO2 MASS GRAMS	1485.4	1489.8	1316.3	1441.8
NOX MASS GRAMS	5.11	5.89	4.80	5.47
HC GRAMS/KM	.08	.06	.06	.08
CO GRAMS/KM	.50	.49	.42	.51
CO2 GRAMS/KM	266.9	237.9	228.8	233.1
NOX GRAMS/KM	.92	.94	.83	.88
FUEL CONSUMPTION BY CB L/100KM	10.81	9.63	9.26	9.44
RUN TIME SECONDS	505.	868.	505.	868.
MEASURED DISTANCE KM	5.56	6.26	5.75	6.18
DFC, WET (DRY)		.960 (.937)		.962 (.939)
SCF, WET (DRY)		1.000 (.971)		1.000 (.971)
VOL (SCM)		332.8		332.3
SAM BLR (SCM)		77.59		77.54
KM (MEASURED)		11.83		11.94
FUEL CONSUMPTION L/100KM		10.19		9.36

COMPOSITE RESULTS

		405-A
TEST NUMBER		
BAROMETER	MM HG	740.4
HUMIDITY	G/KG	14.7
TEMPERATURE	DEG C	24.4

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	241.3	(239.9)
FUEL CONSUMPTION	L/100KM	9.77	(9.71)
HYDROCARBONS (THC)	G/KM	.06	(.07)
CARBON MONOXIDE	G/KM	.48	(.48)
OXIDES OF NITROGEN	G/KM	.91	(.89)

FTP VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 405-B RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 11/28/79
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-405-F
ODOMETER 13076. KM(8125. MILES)

BAROMETER 751.08 MM HG(29.57 IN HG)
RELATIVE HUMIDITY 48. PCT
DRY BULB TEMP. 18.3 DEG C(65.0 DEG F)
ABS. HUMIDITY 6.4 GM/KG

NOX HUMIDITY CORRECTION FACTOR .87

BAG RESULTS

	1	2	3	4
BAG NUMBER / DESCRIPTION	COLD TRANSIENT	STABILIZED	HOT TRANSIENT	STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	792.5 (31.2)	792.5 (31.2)	792.5 (31.2)	792.5 (31.2)
BLOWER INLET P MM. H2O(IN. H2O)	520.7 (20.5)	520.7 (20.5)	520.7 (20.5)	520.7 (20.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	25.6 (78.0)	31.1 (88.0)	26.7 (80.0)	32.2 (90.0)
BLOWER REVOLUTIONS	12533.	21557.	12503.	21564.
TOT FLOW STD. CU. METRES(SCF)	127.8 (4511.)	216.6 (7649.)	127.1 (4488.)	216.1 (7631.)
HC SAMPLE METER/RANGE/PPM	9.5/11/ 9.	6.7/11/ 7.	8.4/11/ 8.	6.9/11/ 7.
HC BCKGRD METER/RANGE/PPM	2.3/ 1/ 2.	1.8/ 1/ 2.	1.8/ 1/ 2.	1.8/ 1/ 2.
CO SAMPLE METER/RANGE/PPM	20.1/13/ 18.	13.5/13/ 12.	18.2/13/ 16.	14.2/13/ 13.
CO BCKGRD METER/RANGE/PPM	.4/13/ 0.	.5/13/ 0.	.1/13/ 0.	.2/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	39.0/ 3/ .66	24.0/ 3/ .39	34.9/ 3/ .58	24.1/ 3/ .39
CO2 BCKGRD METER/RANGE/PCT	2.4/ 3/ .04	2.1/ 3/ .03	2.8/ 3/ .04	2.9/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	24.2/ 2/ 24.	15.4/ 2/ 15.	22.9/ 2/ 23.	15.3/ 2/ 15.
NOX BCKGRD METER/RANGE/PPM	.3/ 2/ 0.	.4/ 2/ 0.	.2/ 2/ 0.	.4/ 2/ 0.
DILUTION FACTOR	20.25	34.18	22.85	34.02
HC CONCENTRATION PPM	7.	5.	7.	5.
CO CONCENTRATION PPM	17.	11.	16.	12.
CO2 CONCENTRATION PCT	.62	.36	.54	.35
NOX CONCENTRATION PPM	23.9	15.0	22.7	14.9
HC MASS GRAMS	.54	.62	.49	.64
CO MASS GRAMS	2.53	2.82	2.31	3.03
CO2 MASS GRAMS	1460.3	1424.3	1263.4	1380.4
NOX MASS GRAMS	5.11	5.44	4.83	5.39
HC GRAMS/KM	.09	.10	.09	.10
CO GRAMS/KM	.44	.46	.40	.49
CO2 GRAMS/KM	254.6	229.7	219.8	221.7
NOX GRAMS/KM	.89	.88	.84	.87
FUEL CONSUMPTION BY CB L/100KM	10.31	9.31	8.90	8.99
RUN TIME SECONDS	505.	868.	504.	869.
MEASURED DISTANCE KM	5.73	6.20	5.75	6.23
DFC, WET (DRY)		.963 (.948)		.965 (.950)
SCF, WET (DRY)		1.000 (.980)		1.000 (.980)
VOL (SCM)		344.4		343.2
SAM BLR (SCM)		78.95		78.90
KM (MEASURED)		11.93		11.98
FUEL CONSUMPTION L/100KM		9.79		8.94

COMPOSITE RESULTS

TEST NUMBER		405-B
BAROMETER	MM HG	751.1
HUMIDITY	G/KG	6.4
TEMPERATURE	DEG C	18.3

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	232.1	(229.8)
FUEL CONSUMPTION	L/100KM	9.40	(9.31)
HYDROCARBONS (THC)	G/KM	.09	(.10)
CARBON MONOXIDE	G/KM	.44	(.45)
OXIDES OF NITROGEN	G/KM	.87	(.87)

85KM/H VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 405-B RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 11/28/79
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-405-F
ODOMETER 13100. KM(8140. MILES)

BAROMETER 753.87 MM HG(29.68 IN HG)
RELATIVE HUMIDITY 19. PCT

DRY BULB TEMP. 21.1 DEG C(70.0 DEG F)
ABS. HUMIDITY 3.0 GM/KG

NOX HUMIDITY CORRECTION FACTOR .80

BAG RESULTS

TEST CYCLE	85KM
BLOWER DIF P MM. H2O(IN. H2O)	792.5 (31.2)
BLOWER INLET P MM. H2O(IN. H2O)	520.7 (20.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	36.7 (98.0)
BLOWER REVOLUTIONS	29984.
TOT FLOW STD. CU. METRES(SCF)	299.2 (10565.)
HC SAMPLE METER/RANGE/PPM	15.4/11/ 15.
HC BCKGRD METER/RANGE/PPM	2.5/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	28.5/13/ 26.
CO BCKGRD METER/RANGE/PPM	.8/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	57.4/ 3/ 1.01
CO2 BCKGRD METER/RANGE/PCT	2.7/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	47.0/ 2/ 47.
NOX BCKGRD METER/RANGE/PPM	1.0/ 2/ 1.
DILUTION FACTOR	13.20
HC CONCENTRATION PPM	13.
CO CONCENTRATION PPM	24.
CO2 CONCENTRATION PCT	.97
NOX CONCENTRATION PPM	46.1
HC MASS GRAMS	2.26
CO MASS GRAMS	8.50
CO2 MASS GRAMS	5331.7
NOX MASS GRAMS	21.03
RUN TIME SECONDS	1201.
DFC, WET (DRY)	.924 (.918)
SCF, WET (DRY)	1.000 (.984)
VOL (SCM)	299.2
SAM BLR (SCM)	70.04
KM (MEASURED)	28.36
TEST NUMBER,	405-B
BAROMETER, MM HG	753.9
HUMIDITY, G/KG	3.0
TEMPERATURE, DEG C	21.1
CARBON DIOXIDE, G/KM	188.0
FUEL CONSUMPTION, L/100KM	7.61
HYDROCARBONS, G/KM	.08
CARBON MONOXIDE, G/KM	.30
OXIDES OF NITROGEN, G/KM	.74

FTP VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 430-A RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 2/ 5/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-430-F
ODOMETER 13150. KM(8171. MILES)

BAROMETER 745.74 MM HG(29.36 IN HG)
RELATIVE HUMIDITY 44. PCT

DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)
ABS. HUMIDITY 7.9 GM/KG

NOX HUMIDITY CORRECTION FACTOR .92

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	COLD TRANSIENT	STABILIZED	HOT TRANSIENT	STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	647.7 (25.5)	647.7 (25.5)	635.0 (25.0)	635.0 (25.0)
BLOWER INLET P MM. H2O(IN. H2O)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	40.6 (105.0)	39.4 (103.0)	40.6 (105.0)	39.4 (103.0)
BLOWER REVOLUTIONS	12551.	21541.	12528.	21540.
TOT FLOW STD. CU. METRES(SCF)	123.3 (4354.)	212.2 (7493.)	123.1 (4348.)	212.3 (7497.)
HC SAMPLE METER/RANGE/PPM	10.3/11/ 10.	7.8/11/ 8.	9.7/11/ 10.	8.5/11/ 8.
HC BCKGRD METER/RANGE/PPM	3.0/ 1/ 3.	3.2/ 1/ 3.	3.2/ 1/ 3.	3.0/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	24.6/13/ 22.	16.7/13/ 15.	21.1/13/ 19.	16.9/13/ 15.
CO BCKGRD METER/RANGE/PPM	.3/13/ 0.	.3/13/ 0.	.1/13/ 0.	.3/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	41.5/ 3/ .71	26.8/ 3/ .44	36.7/ 3/ .62	26.0/ 3/ .43
CO2 BCKGRD METER/RANGE/PCT	2.8/ 3/ .04	2.5/ 3/ .04	2.3/ 3/ .04	2.2/ 3/ .03
NOX SAMPLE METER/RANGE/PPM	24.3/ 2/ 24.	16.4/ 2/ 16.	22.3/ 2/ 22.	15.4/ 2/ 15.
NOX BCKGRD METER/RANGE/PPM	2.0/ 2/ 2.	1.6/ 2/ 2.	1.4/ 2/ 1.	1.4/ 2/ 1.
DILUTION FACTOR	18.90	30.37	21.63	31.36
HC CONCENTRATION PPM	7.	5.	7.	6.
CO CONCENTRATION PPM	21.	14.	18.	14.
CO2 CONCENTRATION PCT	.67	.40	.58	.39
NOX CONCENTRATION PPM	22.4	14.9	21.0	14.0
HC MASS GRAMS	.53	.58	.47	.68
CO MASS GRAMS	3.04	3.50	2.61	3.55
CO2 MASS GRAMS	1501.6	1562.4	1315.1	1525.8
NOX MASS GRAMS	4.84	5.52	4.52	5.22
HC GRAMS/KM	.09	.09	.08	.11
CO GRAMS/KM	.52	.55	.46	.56
CO2 GRAMS/KM	255.3	246.2	229.8	241.7
NOX GRAMS/KM	.82	.87	.79	.83
FUEL CONSUMPTION BY CB L/100KM	10.22	9.86	9.20	9.69
RUN TIME SECONDS	505.	867.	504.	868.
MEASURED DISTANCE KM	5.88	6.34	5.72	6.31
DFC, WET (DRY)	.960 (.946)		.963 (.949)	
SCF, WET (DRY)	1.000 (.981)		1.000 (.981)	
VOL (SCM)		335.5		335.5
SAM BLR (SCM)		78.73		78.73
KM (MEASURED)		12.23		12.03
FUEL CONSUMPTION L/100KM		10.04		9.45

COMPOSITE RESULTS

TEST NUMBER		430-A	3-BAG	(4-BAG)
BAROMETER	MM HG	745.7		
HUMIDITY	G/KG	7.9		
TEMPERATURE	DEG C	23.3		
CARBON DIOXIDE	G/KM		243.7	(242.3)
FUEL CONSUMPTION	L/100KM		9.76	(9.70)
HYDROCARBONS (THC)	G/KM		.09	(.09)
CARBON MONOXIDE	G/KM		.52	(.52)
OXIDES OF NITROGEN	G/KM		.84	(.83)

FTP VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 395-A RUN 2
VEHICLE MODEL 75 MERCEDES BENZ
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 2/11/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-395-F
ODOMETER 13205. KM(8205. MILES)

BAROMETER 740.66 MM HG(29.16 IN HG)
RELATIVE HUMIDITY 17. PCT
DRY BULB TEMP. 22.8 DEG C(73.0 DEG F)
ABS. HUMIDITY 3.0 GM/KG

NOX HUMIDITY CORRECTION FACTOR .80

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	COLD TRANSIENT	STABILIZED	HOT TRANSIENT	STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	635.0 (25.0)	635.0 (25.0)	635.0 (25.0)	635.0 (25.0)
BLOWER INLET P MM. H2O(IN. H2O)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	39.4 (103.0)	36.7 (98.0)	38.9 (102.0)	37.2 (99.0)
BLOWER REVOLUTIONS	12534.	21547.	12538.	21578.
TOT FLOW STD. CU. METRES(SCF)	122.4 (4324.)	211.9 (7482.)	122.6 (4330.)	211.9 (7482.)
HC SAMPLE METER/RANGE/PPM	10.0/11/ 10.	7.9/11/ 8.	9.1/11/ 9.	7.4/11/ 7.
HC BCKGRD METER/RANGE/PPM	2.2/ 1/ 2.	2.8/ 1/ 3.	2.8/ 1/ 3.	2.9/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	21.0/13/ 19.	14.3/13/ 13.	19.0/13/ 17.	14.3/13/ 13.
CO BCKGRD METER/RANGE/PPM	.7/13/ 1.	.3/13/ 0.	.2/13/ 0.	.1/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	41.9/ 3/ .71	27.6/ 3/ .45	38.8/ 3/ .66	26.9/ 3/ .44
CO2 BCKGRD METER/RANGE/PCT	2.7/ 3/ .04	2.9/ 3/ .04	3.0/ 3/ .05	2.8/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	24.1/ 2/ 24.	17.5/ 2/ 18.	24.2/ 2/ 24.	17.1/ 2/ 17.
NOX BCKGRD METER/RANGE/PPM	.9/ 2/ 1.	.9/ 2/ 1.	.8/ 2/ 1.	.9/ 2/ 1.
DILUTION FACTOR	18.71	29.44	20.36	30.26
HC CONCENTRATION PPM	8.	5.	6.	5.
CO CONCENTRATION PPM	18.	12.	16.	12.
CO2 CONCENTRATION PCT	.67	.41	.61	.40
NOX CONCENTRATION PPM	23.2	16.6	23.4	16.2
HC MASS GRAMS	.56	.63	.46	.56
CO MASS GRAMS	2.53	3.00	2.34	3.04
CO2 MASS GRAMS	1511.2	1591.6	1373.7	1549.6
NOX MASS GRAMS	4.34	5.37	4.38	5.24
HC GRAMS/KM	.10	.10	.08	.09
CO GRAMS/KM	.44	.47	.40	.48
CO2 GRAMS/KM	261.6	251.0	234.6	243.0
NOX GRAMS/KM	.75	.85	.75	.82
FUEL CONSUMPTION BY CB L/100KM	11.38	10.92	10.20	10.57
RUN TIME SECONDS	504.	867.	504.	868.
MEASURED DISTANCE KM	5.78	6.34	5.86	6.38
DFC, WET (DRY)	.959 (.954)		.961 (.956)	
SCF, WET (DRY)	1.000 (.989)		1.000 (.990)	
VOL (SCM)		334.3		334.5
SAM BLR (SCM)		78.54		78.26
KM (MEASURED)		12.12		12.23
FUEL CONSUMPTION L/100KM		11.14		10.39

COMPOSITE RESULTS

TEST NUMBER		395-A
BAROMETER	MM HG	740.7
HUMIDITY	G/KG	3.0
TEMPERATURE	DEG C	22.8

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	248.7	(246.3)
FUEL CONSUMPTION	L/100KM	10.82	(10.71)
HYDROCARBONS (THC)	G/KM	.09	(.09)
CARBON MONOXIDE	G/KM	.45	(.45)
OXIDES OF NITROGEN	G/KM	.80	(.79)

FTP VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 395-E RUN 1
VEHICLE MODEL 75 MERCEDES BENZ
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 2/14/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-395-F
ODOMETER 13243. KM(8229. MILES)

BAROMETER 740.92 MM HG(29.17 IN HG)
RELATIVE HUMIDITY 62. PCT
DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)
ABS. HUMIDITY 11.9 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.04

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	635.0 (25.0)	635.0 (25.0)	635.0 (25.0)	635.0 (25.0)
BLOWER INLET P MM. H2O(IN. H2O)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	40.6 (105.0)	40.6 (105.0)	36.7 (98.0)	36.7 (98.0)
BLOWER REVOLUTIONS	12545.	21581.	12536.	21561.
TOT FLOW STD. CU. METRES(SCF)	121.9 (4306.)	209.8 (7407.)	123.0 (4343.)	211.5 (7469.)
HC SAMPLE METER/RANGE/PPM	11.7/11/ 12.	9.2/11/ 9.	10.7/11/ 11.	8.7/11/ 9.
HC BCKGRD METER/RANGE/PPM	4.6/ 1/ 5.	4.2/ 1/ 4.	4.2/ 1/ 4.	3.8/ 1/ 4.
CO SAMPLE METER/RANGE/PPM	23.1/13/ 21.	16.1/13/ 14.	20.3/13/ 18.	15.2/13/ 13.
CO BCKGRD METER/RANGE/PPM	.7/13/ 1.	.3/13/ 0.	.2/13/ 0.	.4/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	41.1/ 3/ .70	26.8/ 3/ .44	36.5/ 3/ .61	25.2/ 3/ .41
CO2 BCKGRD METER/RANGE/PCT	2.7/ 3/ .04	2.8/ 3/ .04	2.9/ 3/ .04	3.1/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	18.8/ 2/ 19.	13.4/ 2/ 13.	18.6/ 2/ 19.	13.0/ 2/ 13.
NOX BCKGRD METER/RANGE/PPM	.4/ 2/ 0.	.3/ 2/ 0.	.6/ 2/ 1.	.4/ 2/ 0.
DILUTION FACTOR	19.11	30.36	21.76	32.43
HC CONCENTRATION PPM	7.	5.	7.	5.
CO CONCENTRATION PPM	19.	14.	17.	13.
CO2 CONCENTRATION PCT	.66	.40	.57	.37
NOX CONCENTRATION PPM	18.4	13.1	18.0	12.6
HC MASS GRAMS	.51	.62	.48	.61
CO MASS GRAMS	2.75	3.31	2.48	3.13
CO2 MASS GRAMS	1471.5	1527.3	1285.3	1413.9
NOX MASS GRAMS	4.46	5.47	4.41	5.30
HC GRAMS/KM	.09	.10	.08	.10
CO GRAMS/KM	.48	.53	.43	.50
CO2 GRAMS/KM	254.7	242.9	221.9	224.7
NOX GRAMS/KM	.77	.87	.76	.84
FUEL CONSUMPTION BY CB L/100KM	10.35	9.87	9.01	9.13
RUN TIME SECONDS	505.	868.	504.	867.
MEASURED DISTANCE KM	5.78	6.29	5.79	6.29
DFC, WET (DRY)	.960 (.941)		.964 (.944)	
SCF, WET (DRY)	1.000 (.975)		1.000 (.975)	
VOL (SCM)		331.7		334.5
SAM BLR (SCM)		78.04		77.96
KM (MEASURED)		12.07		12.08
FUEL CONSUMPTION L/100KM		10.10		9.08

COMPOSITE RESULTS

TEST NUMBER		395-E
BAROMETER	MM HG	740.9
HUMIDITY	G/KG	11.9
TEMPERATURE	DEG C	23.9

		3-BAG	(4-BAG
CARBON DIOXIDE	G/KM	239.6	(234.2
FUEL CONSUMPTION	L/100KM	9.73	(9.52
HYDROCARBONS (THC)	G/KM	.09	(.09
CARBON MONOXIDE	G/KM	.49	(.48
OXIDES OF NITROGEN	G/KM	.82	(.81

FTP VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 434-A RUN 1
VEHICLE MODEL 75 MERCEDES 240-D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 2/28/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-434-F
ODOMETER 13284. KM(8254. MILES)

BAROMETER 738.38 MM HG(29.07 IN HG)
RELATIVE HUMIDITY 42. PCT
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)
ABS. HUMIDITY 8.6 GM/KG

NOX HUMIDITY CORRECTION FACTOR .94

BAG RESULTS

BAG NUMBER / DESCRIPTION	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)
BLOWER INLET P MM. H2O(IN. H2O)	487.7 (19.2)	487.7 (19.2)	487.7 (19.2)	487.7 (19.2)
BLOWER INLET TEMP. DEG. C(DEG. F)	42.2 (108.0)	35.0 (95.0)	38.9 (102.0)	38.9 (102.0)
BLOWER REVOLUTIONS	12785.	21983.	12777.	21971.
TOT FLOW STD. CU. METRES(SCF)	123.2 (4350.)	215.5 (7609.)	124.1 (4381.)	213.3 (7533.)
HC SAMPLE METER/RANGE/PPM	12.9/11/ 13.	9.7/11/ 10.	10.8/11/ 11.	10.0/11/ 10.
HC BCKGRD METER/RANGE/PPM	4.2/ 1/ 4.	3.0/ 1/ 3.	3.0/ 1/ 3.	2.8/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	26.3/13/ 24.	19.4/13/ 17.	23.1/13/ 21.	19.8/13/ 18.
CO BCKGRD METER/RANGE/PPM	1.4/13/ 1.	1.0/13/ 1.	1.4/13/ 1.	1.4/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	41.2/ 3/ .70	26.7/ 3/ .44	35.6/ 3/ .60	25.3/ 3/ .41
CO2 BCKGRD METER/RANGE/PCT	2.5/ 3/ .04	2.6/ 3/ .04	2.5/ 3/ .04	2.3/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	22.9/ 2/ 23.	15.8/ 2/ 16.	21.6/ 2/ 22.	15.3/ 2/ 15.
NOX BCKGRD METER/RANGE/PPM	.7/ 2/ 1.	.8/ 2/ 1.	.7/ 2/ 1.	.9/ 2/ 1.
DILUTION FACTOR	19.04	30.46	22.34	32.25
HC CONCENTRATION PPM	9.	7.	8.	7.
CO CONCENTRATION PPM	22.	16.	19.	16.
CO2 CONCENTRATION PCT	.66	.40	.56	.38
NOX CONCENTRATION PPM	22.2	15.0	20.9	14.4
HC MASS GRAMS	.64	.84	.57	.89
CO MASS GRAMS	3.13	4.02	2.74	3.99
CO2 MASS GRAMS	1497.4	1573.6	1272.4	1479.6
NOX MASS GRAMS	4.90	5.79	4.65	5.51
HC GRAMS/KM	.11	.14	.10	.14
CO GRAMS/KM	.54	.65	.47	.64
CO2 GRAMS/KM	257.6	254.2	219.1	238.9
NOX GRAMS/KM	.84	.94	.80	.89
FUEL CONSUMPTION BY CB L/100KM	9.89	9.77	8.41	9.18
RUN TIME SECONDS	505.	868.	505.	868.
MEASURED DISTANCE KM	5.81	6.19	5.81	6.19
DFC, WET (DRY)	.960 (.947)		.964 (.951)	
SCF, WET (DRY)	1.000 (.981)		1.000 (.982)	
VOL (SCM)	338.7		337.4	
SAM BLR (SCM)	77.50		77.42	
KM (MEASURED)	12.00		12.00	
FUEL CONSUMPTION L/100KM	9.82		8.81	

COMPOSITE RESULTS

TEST NUMBER		434-A
BAROMETER	MM HG	738.4
HUMIDITY	G/KG	8.6
TEMPERATURE	DEG C	25.0

		3-BAG	(4-BAG
CARBON DIOXIDE	G/KM	245.2	(240.7
FUEL CONSUMPTION	L/100KM	9.42	(9.25
HYDROCARBONS (THC)	G/KM	.12	(.12
CARBON MONOXIDE	G/KM	.58	(.58
OXIDES OF NITROGEN	G/KM	.88	(.87

FTP-C VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 434-B RUN 1
VEHICLE MODEL 75 MERCEDES BENZ
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO. 1
DATE 3/12/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-434-F
ODOMETER 13321. KM(8277. MILES)

BAROMETER 733.81 MM HG(28.89 IN HG)
RELATIVE HUMIDITY 35. PCT
DRY BULB TEMP. 22.2 DEG C(72.0 DEG F)
ABS. HUMIDITY 6.1 GM/KG

NOX HUMIDITY CORRECTION FACTOR .87

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	635.0 (25.0)	635.0 (25.0)	635.0 (25.0)	635.0 (25.0)
BLOWER INLET P MM. H2O(IN. H2O)	495.3 (19.5)	495.3 (19.5)	495.3 (19.5)	495.3 (19.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	36.7 (98.0)	35.0 (95.0)	32.2 (90.0)	36.1 (97.0)
BLOWER REVOLUTIONS	12785.	21974.	12775.	21989.
TOT FLOW STD. CU. METRES(SCF)	123.6 (4366.)	213.4 (7535.)	124.9 (4409.)	212.9 (7517.)
HC SAMPLE METER/RANGE/PPM	12.0/11/ 12.	8.2/11/ 8.	9.8/11/ 10.	8.8/11/ 9.
HC BCKGRD METER/RANGE/PPM	2.4/ 1/ 2.	2.0/ 1/ 2.	2.0/ 1/ 2.	1.9/ 1/ 2.
CO SAMPLE METER/RANGE/PPM	26.3/13/ 24.	19.8/13/ 18.	25.3/13/ 23.	22.1/13/ 20.
CO BCKGRD METER/RANGE/PPM	1.0/13/ 1.	1.0/13/ 1.	1.6/13/ 1.	1.8/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	41.7/ 3/ .71	27.3/ 3/ .45	37.5/ 3/ .63	27.8/ 3/ .46
CO2 BCKGRD METER/RANGE/PCT	2.6/ 3/ .04	2.7/ 3/ .04	2.6/ 3/ .04	2.6/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	24.9/ 2/ 25.	16.8/ 2/ 17.	24.2/ 2/ 24.	17.5/ 2/ 18.
NOX BCKGRD METER/RANGE/PPM	.5/ 2/ 1.	.7/ 2/ 1.	.6/ 2/ 1.	.7/ 2/ 1.
DILUTION FACTOR	18.80	29.75	21.11	29.16
HC CONCENTRATION PPM	10.	6.	8.	7.
CO CONCENTRATION PPM	22.	16.	21.	18.
CO2 CONCENTRATION PCT	.67	.41	.59	.42
NOX CONCENTRATION PPM	24.4	16.1	23.6	16.8
HC MASS GRAMS	.69	.77	.57	.86
CO MASS GRAMS	3.20	4.08	3.03	4.42
CO2 MASS GRAMS	1520.8	1593.8	1357.2	1630.3
NOX MASS GRAMS	5.01	5.71	4.90	5.94
HC GRAMS/KM	.12	.12	.10	.14
CO GRAMS/KM	.55	.65	.52	.70
CO2 GRAMS/KM	261.6	254.5	233.5	258.4
NOX GRAMS/KM	.86	.91	.84	.94
FUEL CONSUMPTION BY CB L/100KM	10.04	9.78	8.96	9.93
RUN TIME SECONDS	505.	868.	505.	868.
MEASURED DISTANCE KM	5.81	6.26	5.81	6.31
DFC, WET (DRY)		.959 (.948)	.961 (.950)	
SCF, WET (DRY)		1.000 (.984)	1.000 (.984)	
VOL (SCM)		337.0	337.8	
SAM BLR (SCM)		76.59	76.48	
KM (MEASURED)		12.08	12.12	
FUEL CONSUMPTION L/100KM		9.90	9.47	

COMPOSITE RESULTS

		434-B
TEST NUMBER		
BAROMETER	MM HG	733.8
HUMIDITY	G/KG	6.1
TEMPERATURE	DEG C	22.2

		3-BAG	(4-BAG
CARBON DIOXIDE	G/KM	250.2	(251.4
FUEL CONSUMPTION	L/100KM	9.61	(9.65
HYDROCARBONS (THC)	G/KM	.12	(.12
CARBON MONOXIDE	G/KM	.59	(.61
OXIDES OF NITROGEN	G/KM	.88	(.89

TEST NO. 434-B RUN 1
VEHICLE MODEL 75 MERCEDES BENZ
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

BAROMETER 731.77 MM HG(28.81 IN HG)
RELATIVE HUMIDITY 24. PCT
BAG RESULTS
TEST CYCLE

BLOWER DIF P MM. H2O(IN. H2O)
BLOWER INLET P MM. H2O(IN. H2O)
BLOWER INLET TEMP. DEG. C(DEG. F)
BLOWER REVOLUTIONS
TOT FLOW STD. CU. METRES(SCF)
HC SAMPLE METER/RANGE/PPM
HC BCKGRD METER/RANGE/PPM
CO SAMPLE METER/RANGE/PPM
CO BCKGRD METER/RANGE/PPM
CO2 SAMPLE METER/RANGE/PCT
CO2 BCKGRD METER/RANGE/PCT
NOX SAMPLE METER/RANGE/PPM
NOX BCKGRD METER/RANGE/PPM
DILUTION FACTOR
HC CONCENTRATION PPM
CO CONCENTRATION PPM
CO2 CONCENTRATION PCT
NOX CONCENTRATION PPM
HC MASS GRAMS
CO MASS GRAMS
CO2 MASS GRAMS
NOX MASS GRAMS
RUN TIME SECONDS
DFC, WET (DRY)
SCF, WET (DRY)
VOL (SCM)
SAM BLR (SCM)
KM (MEASURED)

TEST NUMBER,
BAROMETER, MM HG
HUMIDITY, G/KG
TEMPERATURE, DEG C
CARBON DIOXIDE, G/KM
FUEL CONSUMPTION, L/100KM

HYDROCARBONS, G/KM
CARBON MONOXIDE, G/KM
OXIDES OF NITROGEN, G/KM

85KM/H VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

VEHICLE NO.1
DATE 3/12/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-434-F
ODOMETER 13345. KM(8292. MILES)

DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)
ABS. HUMIDITY 4.9 GM/KG

NOX HUMIDITY CORRECTION FACTOR .84

85KM

635.0 (25.0)
495.3 (19.5)
36.7 (98.0)
30449.
293.4 (10360.)
15.1/11/ 15.
2.0/ 1/ 2.
38.7/13/ 36.
1.3/13/ 1.
59.1/ 3/ 1.05
2.4/ 3/ .04
49.6/ 2/ 50.
.9/ 2/ 1.
12.76
13.
34.
1.01
48.8
2.24
11.47
5432.2
22.99
1202.
.922 (.914)
1.000 (.983)
293.4
66.06
28.20

434-B
731.8
4.9
25.0
192.7
7.39

.08
.41
.82

85KM/H VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 434-D RUN 1
VEHICLE MODEL 75 MERCEDES BENZ
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO. 1
DATE 3/13/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-434-F
ODOMETER 13403. KM(8328. MILES)

BAROMETER 744.98 MM HG(29.33 IN HG)
RELATIVE HUMIDITY 24. PCT
DRY BULB TEMP. 20.0 DEG C(68.0 DEG F)
ABS. HUMIDITY 3.6 GM/KG

NOX HUMIDITY CORRECTION FACTOR .81

0 BAG RESULTS
TEST CYCLE

	85KM
BLOWER DIF P MM. H2O(IN. H2O)	635.0 (25.0)
BLOWER INLET P MM. H2O(IN. H2O)	495.3 (19.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	37.8 (100.0)
BLOWER REVOLUTIONS	30396.
TOT FLOW STD. CU. METRES(SCF)	297.8 (10516.)
HC SAMPLE METER/RANGE/PPM	14.3/11/ 14.
HC BCKGRD METER/RANGE/PPM	2.0/ 1/ 2.
CO SAMPLE METER/RANGE/PPM	42.8/13/ 40.
CO BCKGRD METER/RANGE/PPM	.1/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	60.5/ 3/ 1.07
CO2 BCKGRD METER/RANGE/PCT	2.6/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	54.1/ 2/ 54.
NOX BCKGRD METER/RANGE/PPM	1.0/ 2/ 1.
DILUTION FACTOR	12.43
HC CONCENTRATION PPM	12.
CO CONCENTRATION PPM	39.
CO2 CONCENTRATION PCT	1.04
NOX CONCENTRATION PPM	53.2
HC MASS GRAMS	2.14
CO MASS GRAMS	13.36
CO2 MASS GRAMS	5651.0
NOX MASS GRAMS	24.52
RUN TIME SECONDS	1200.
DFC, WET (DRY)	.920 (.912)
SCF, WET (DRY)	1.000 (.982)
VOL (SCM)	297.8
SAM BLR (SCM)	68.89
KM (MEASURED)	28.24

TEST NUMBER,		434-D
BAROMETER,	MM HG	745.0
HUMIDITY,	G/KG	3.6
TEMPERATURE,	DEG C	20.0
CARBON DIOXIDE,	G/KM	200.1
FUEL CONSUMPTION,	L/100KM	7.68
HYDROCARBONS,	G/KM	.08
CARBON MONOXIDE,	G/KM	.47
OXIDES OF NITROGEN,	G/KM	.87

85KM/H VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 434-D RUN 2
VEHICLE MODEL 75 MERCEDES 240-D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 3/21/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-434-F
ODOMETER 13472. KM(8371. MILES)

BAROMETER 745.74 MM HG(29.36 IN HG)
RELATIVE HUMIDITY 23. PCT
DRY BULB TEMP. 21.1 DEG C(70.0 DEG F)
ABS. HUMIDITY 3.6 GM/KG

NOX HUMIDITY CORRECTION FACTOR .81

0 BAG RESULTS

TEST CYCLE	85KM
BLOWER DIF P MM. H2O(IN. H2O)	647.7 (25.5)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	37.8 (100.0)
BLOWER REVOLUTIONS	30386.
TOT FLOW STD. CU. METRES(SCF)	298.4 (10536.)
HC SAMPLE METER/RANGE/PPM	14.4/11/ 14.
HC BCKGRD METER/RANGE/PPM	2.2/ 1/ 2.
CO SAMPLE METER/RANGE/PPM	41.0/13/ 38.
CO BCKGRD METER/RANGE/PPM	.2/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	60.3/ 3/ 1.07
CO2 BCKGRD METER/RANGE/PCT	2.5/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	53.6/ 2/ 54.
NOX BCKGRD METER/RANGE/PPM	.7/ 2/ 1.
DILUTION FACTOR	12.48
0 HC CONCENTRATION PPM	12.
CO CONCENTRATION PPM	37.
CO2 CONCENTRATION PCT	1.03
NOX CONCENTRATION PPM	53.0
HC MASS GRAMS	2.13
CO MASS GRAMS	12.75
CO2 MASS GRAMS	5647.7
NOX MASS GRAMS	24.49
RUN TIME SECONDS	1201.
DFC, WET (DRY)	.920 (.913)
SCF, WET (DRY)	1.000 (.983)
VOL (SCM)	298.4
SAM BLR (SCM)	68.20
KM (MEASURED)	28.26
TEST NUMBER,	434-D
BAROMETER, MM HG	745.7
HUMIDITY, G/KG	3.6
TEMPERATURE, DEG C	21.1
CARBON DIOXIDE, G/KM	199.8
FUEL CONSUMPTION, L/100KM	7.67
HYDROCARBONS, G/KM	.08
CARBON MONOXIDE, G/KM	.45
OXIDES OF NITROGEN, G/KM	.97

FTP VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 438-A RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 3/28/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-438-F
ODOMETER 13531. KM(8408. MILES)

BAROMETER 737.87 MM HG(29.05 IN HG)
RELATIVE HUMIDITY 38. PCT

DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)
ABS. HUMIDITY 7.5 GM/KG

NOX HUMIDITY CORRECTION FACTOR .91

BAG RESULTS

BAG NUMBER / DESCRIPTION	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	609.6 (24.0)	482.6 (19.0)	614.7 (24.2)	619.8 (24.4)
BLOWER INLET P MM. H2O(IN. H2O)	490.2 (19.3)	614.7 (24.2)	485.1 (19.1)	487.7 (19.2)
BLOWER INLET TEMP. DEG. C(DEG. F)	37.8 (100.0)	36.7 (98.0)	37.2 (99.0)	36.1 (97.0)
BLOWER REVOLUTIONS	12791.	21999.	12776.	21991.
TOT FLOW STD. CU. METRES(SCF)	125.4 (4427.)	214.6 (7578.)	125.3 (4424.)	216.2 (7633.)
HC SAMPLE METER/RANGE/PPM	9.3/11/ 9.	6.7/11/ 7.	8.4/11/ 8.	6.9/11/ 7.
HC BCKGRD METER/RANGE/PPM	2.8/ 1/ 3.	2.6/ 1/ 3.	2.6/ 1/ 3.	2.0/ 1/ 2.
CO SAMPLE METER/RANGE/PPM	22.7/13/ 20.	15.8/13/ 14.	20.4/13/ 18.	16.3/13/ 14.
CO BCKGRD METER/RANGE/PPM	.6/13/ 1.	.3/13/ 0.	.4/13/ 0.	.4/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	40.8/ 3/ .69	25.8/ 3/ .42	36.1/ 3/ .61	25.6/ 3/ .42
CO2 BCKGRD METER/RANGE/PCT	2.6/ 3/ .04	2.8/ 3/ .04	2.6/ 3/ .04	2.9/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	22.3/ 2/ 22.	15.3/ 2/ 15.	22.7/ 2/ 23.	15.9/ 2/ 16.
NOX BCKGRD METER/RANGE/PPM	.6/ 2/ 1.	.5/ 2/ 1.	1.2/ 2/ 1.	.9/ 2/ 1.
DILUTION FACTOR	19.27	31.63	22.02	31.89
HC CONCENTRATION PPM	7.	4.	6.	5.
CO CONCENTRATION PPM	19.	13.	17.	14.
CO2 CONCENTRATION PCT	.65	.38	.57	.38
NOX CONCENTRATION PPM	21.7	14.8	21.6	15.0
HC MASS GRAMS	.48	.52	.43	.61
CO MASS GRAMS	2.81	3.35	2.54	3.47
CO2 MASS GRAMS	1503.3	1493.3	1302.7	1484.4
NOX MASS GRAMS	4.72	5.51	4.68	5.63
HC GRAMS/KM	.08	.09	.07	.10
CO GRAMS/KM	.49	.55	.44	.56
CO2 GRAMS/KM	260.7	244.1	225.4	238.5
NOX GRAMS/KM	.82	.90	.81	.90
FUEL CONSUMPTION BY CB L/100KM	10.65	9.98	9.21	9.76
RUN TIME SECONDS	505.	864.	504.	868.
MEASURED DISTANCE KM	5.77	6.12	5.78	6.22
DFC, WET (DRY)	.961 (.949)		.963 (.952)	
SCF, WET (DRY)	1.000 (.983)		1.000 (.983)	
VOL (SCM)		340.0		341.5
SAM BLR (SCM)		78.93		78.76
KM (MEASURED)		11.88		12.00
FUEL CONSUMPTION L/100KM		10.31		9.49

COMPOSITE RESULTS

TEST NUMBER		438-A
BAROMETER	MM HG	737.9
HUMIDITY	G/KG	7.5
TEMPERATURE	DEG C	24.4

		3-BAG	(4-BAG
CARBON DIOXIDE	G/KM	242.4	(240.8
FUEL CONSUMPTION	L/100KM	9.91	(9.84
HYDROCARBONS (THC)	G/KM	.08	(.09
CARBON MONOXIDE	G/KM	.51	(.51
OXIDES OF NITROGEN	G/KM	.86	(.86

FTP VEHICLE EMISSIONS RESULTS -
PROJECT 11-5423-001

TEST NO. 438-E RUN 1
VEHICLE MODEL 75 MERCEDES BENZ
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4
GVW 1492. KG(3289. LBS)

VEHICLE NO.1
DATE 4/ 3/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-438-F
ODOMETER 13575. KM(8435. MILES)

BAROMETER 740.41 MM HG(29.15 IN HG)
RELATIVE HUMIDITY 34. PCT
DRY BULB TEMP. 25.6 DEG C(78.0 DEG F)
ABS. HUMIDITY 7.0 GM/KG

NOX HUMIDITY CORRECTION FACTOR .89

BAG RESULTS

BAG NUMBER / DESCRIPTION	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	36.7 (98.0)	37.2 (99.0)	37.8 (100.0)	37.8 (100.0)
BLOWER REVOLUTIONS	12779.	21994.	12794.	21981.
TOT FLOW STD. CU. METRES(SCF)	125.4 (4426.)	215.5 (7608.)	125.1 (4419.)	215.0 (7593.)
HC SAMPLE METER/RANGE/PPM	10.2/11/ 10.	7.7/11/ 8.	9.4/11/ 9.	7.9/11/ 8.
HC BCKGRD METER/RANGE/PPM	2.6/ 1/ 3.	3.1/ 1/ 3.	3.1/ 1/ 3.	2.9/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	20.4/13/ 18.	14.4/13/ 13.	18.8/13/ 17.	14.6/13/ 13.
CO BCKGRD METER/RANGE/PPM	.6/13/ 1.	.3/13/ 0.	.3/13/ 0.	.1/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	41.0/ 3/ .70	25.6/ 3/ .42	35.9/ 3/ .60	24.7/ 3/ .40
CO2 BCKGRD METER/RANGE/PCT	3.1/ 3/ .05	3.0/ 3/ .05	3.2/ 3/ .05	3.0/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	24.3/ 2/ 24.	16.0/ 2/ 16.	22.4/ 2/ 22.	15.8/ 2/ 16.
NOX BCKGRD METER/RANGE/PPM	1.8/ 2/ 2.	1.6/ 2/ 2.	1.5/ 2/ 2.	1.7/ 2/ 2.
DILUTION FACTOR	19.17	31.90	22.16	33.13
HC CONCENTRATION PPM	8.	5.	6.	5.
CO CONCENTRATION PPM	17.	12.	16.	13.
CO2 CONCENTRATION PCT	.65	.37	.56	.36
NOX CONCENTRATION PPM	22.6	14.5	21.0	14.2
HC MASS GRAMS	.56	.58	.46	.63
CO MASS GRAMS	2.51	3.06	2.34	3.14
CO2 MASS GRAMS	1494.9	1473.7	1272.5	1408.8
NOX MASS GRAMS	4.83	5.31	4.48	5.19
HC GRAMS/KM	.10	.09	.08	.10
CO GRAMS/KM	.44	.49	.41	.51
CO2 GRAMS/KM	261.1	237.9	224.5	227.5
NOX GRAMS/KM	.84	.86	.79	.84
FUEL CONSUMPTION BY CB L/100KM	10.67	9.73	9.18	9.31
RUN TIME SECONDS	504.	868.	505.	868.
MEASURED DISTANCE KM	5.72	6.19	5.67	6.19
DFC, WET (DRY)	.961 (.951)		.964 (.954)	
SCF, WET (DRY)	1.000 (.984)		1.000 (.985)	
VOL (SCM)		340.8		340.2
SAM BLR (SCM)		78.37		78.34
KM (MEASURED)		11.92		11.86
FUEL CONSUMPTION L/100KM		10.18		9.24

COMPOSITE RESULTS

TEST NUMBER		438-E
BAROMETER	MM HG	740.4
HUMIDITY	G/KG	7.0
TEMPERATURE	DEG C	25.6

		3-BAG	(4-BAG
CARBON DIOXIDE	G/KM	239.1	(236.0
FUEL CONSUMPTION	L/100KM	9.77	(9.65
HYDROCARBONS (THC)	G/KM	.09	(.09
CARBON MONOXIDE	G/KM	.46	(.46
OXIDES OF NITROGEN	G/KM	.84	(.83

FTP VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 448-A RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 4/30/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-448-F
ODOMETER 13675. KM(8497. MILES)

BAROMETER 732.03 MM HG(28.82 IN HG)
RELATIVE HUMIDITY 52. PCT
DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)
ABS. HUMIDITY 9.9 GM/KG

NOX HUMIDITY CORRECTION FACTOR .97

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	36.7 (98.0)	36.1 (97.0)	36.7 (98.0)	36.7 (98.0)
BLOWER REVOLUTIONS	12780.	21968.	12790.	21952.
TOT FLOW STD. CU. METRES(SCF)	123.7 (4368.)	212.9 (7519.)	123.8 (4371.)	212.5 (7502.)
HC SAMPLE METER/RANGE/PPM	11.7/11/ 12.	9.2/11/ 9.	10.4/11/ 10.	9.0/11/ 9.
HC BCKGRD METER/RANGE/PPM	3.8/ 1/ 4.	3.5/ 1/ 4.	3.5/ 1/ 4.	3.3/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	21.5/13/ 19.	14.9/13/ 13.	19.6/13/ 17.	14.6/13/ 13.
CO BCKGRD METER/RANGE/PPM	.1/13/ 0.	.3/13/ 0.	.2/13/ 0.	.1/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	38.5/ 3/ .65	24.5/ 3/ .40	35.0/ 3/ .59	24.2/ 3/ .39
CO2 BCKGRD METER/RANGE/PCT	3.0/ 3/ .05	2.9/ 3/ .04	3.0/ 3/ .05	3.0/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	20.8/ 2/ 21.	13.5/ 2/ 14.	19.5/ 2/ 20.	12.7/ 2/ 13.
NOX BCKGRD METER/RANGE/PPM	1.0/ 2/ 1.	.8/ 2/ 1.	.7/ 2/ 1.	.6/ 2/ 1.
DILUTION FACTOR	20.52	33.41	22.77	33.85
HC CONCENTRATION PPM	8.	6.	7.	6.
CO CONCENTRATION PPM	19.	13.	17.	12.
CO2 CONCENTRATION PCT	.61	.36	.54	.35
NOX CONCENTRATION PPM	19.8	12.7	18.8	12.1
HC MASS GRAMS	.58	.72	.50	.71
CO MASS GRAMS	2.67	3.12	2.42	3.09
CO2 MASS GRAMS	1373.1	1387.4	1228.0	1358.2
NOX MASS GRAMS	4.57	5.04	4.34	4.79
HC GRAMS/KM	.10	.12	.09	.12
CO GRAMS/KM	.47	.51	.42	.51
CO2 GRAMS/KM	242.4	226.3	215.9	222.7
NOX GRAMS/KM	.81	.82	.76	.79
FUEL CONSUMPTION BY CB L/100KM	9.98	9.32	8.89	9.17
RUN TIME SECONDS	505.	868.	505.	867.
MEASURED DISTANCE KM	5.66	6.13	5.69	6.10
DFC, WET (DRY)	.963 (.947)		.965 (.949)	
SCF, WET (DRY)	1.000 (.979)		1.000 (.979)	
VOL (SCM)		336.7		336.3
SAM BLR (SCM)		76.22		76.16
KM (MEASURED)		11.79		11.79
FUEL CONSUMPTION L/100KM		9.64		9.03

COMPOSITE RESULTS

TEST NUMBER		448-A
BAROMETER	MM HG	732.0
HUMIDITY	G/KG	9.9
TEMPERATURE	DEG C	23.9

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	226.8	(225.7)
FUEL CONSUMPTION	L/100KM	9.34	(9.29)
HYDROCARBONS (THC)	G/KM	.11	(.11)
CARBON MONOXIDE	G/KM	.48	(.48)
OXIDES OF NITROGEN	G/KM	.80	(.79)

FTP VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 448-A RUN 2
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 5/ 7/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-448-F
ODOMETER 6960. KM(4325. MILES)

BAROMETER 735.33 MM HG(28.95 IN HG)
RELATIVE HUMIDITY 55. PCT
DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)
ABS. HUMIDITY 10.5 GM/KG
NOX HUMIDITY CORRECTION FACTOR .99

BAG RESULTS

BAG NUMBER / DESCRIPTION	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	37.2 (99.0)	37.8 (100.0)	36.1 (97.0)	37.2 (99.0)
BLOWER REVOLUTIONS	12761.	21941.	12767.	21967.
TOT FLOW STD. CU. METRES(SCF)	124.1 (4382.)	213.1 (7524.)	124.5 (4395.)	213.6 (7542.)
HC SAMPLE METER/RANGE/PPM	13.0/11/ 13.	10.2/11/ 10.	12.5/11/ 12.	10.6/11/ 11.
HC BCKGRD METER/RANGE/PPM	4.2/ 1/ 4.	4.5/ 1/ 5.	4.5/ 1/ 5.	4.8/ 1/ 5.
CO SAMPLE METER/RANGE/PPM	21.2/13/ 19.	14.8/13/ 13.	20.6/13/ 18.	16.3/13/ 14.
CO BCKGRD METER/RANGE/PPM	.2/13/ 0.	.3/13/ 0.	.8/13/ 1.	.1/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	38.8/ 3/ .66	25.6/ 3/ .42	35.1/ 3/ .59	25.3/ 3/ .41
CO2 BCKGRD METER/RANGE/PCT	3.0/ 3/ .05	3.0/ 3/ .05	2.8/ 3/ .04	2.9/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	19.4/ 2/ 19.	13.2/ 2/ 13.	19.3/ 2/ 19.	13.1/ 2/ 13.
NOX BCKGRD METER/RANGE/PPM	.4/ 2/ 0.	.3/ 2/ 0.	.3/ 2/ 0.	.4/ 2/ 0.
DILUTION FACTOR	20.35	31.88	22.69	32.27
HC CONCENTRATION PPM	9.	6.	8.	6.
CO CONCENTRATION PPM	18.	12.	17.	14.
CO2 CONCENTRATION PCT	.61	.37	.55	.37
NOX CONCENTRATION PPM	19.0	12.9	19.0	12.7
HC MASS GRAMS	.64	.71	.59	.74
CO MASS GRAMS	2.62	3.09	2.48	3.47
CO2 MASS GRAMS	1390.0	1457.3	1245.7	1446.3
NOX MASS GRAMS	4.49	5.23	4.50	5.16
HC GRAMS/KM	.12	.12	.10	.12
CO GRAMS/KM	.48	.50	.43	.56
CO2 GRAMS/KM	254.4	237.9	217.5	233.6
NOX GRAMS/KM	.82	.85	.79	.83
FUEL CONSUMPTION BY CB L/100KM	10.45	9.78	8.93	9.60
RUN TIME SECONDS	504.	867.	504.	868.
MEASURED DISTANCE KM	5.46	6.12	5.73	6.19
DFC, WET (DRY)	.962 (.945)		.964 (.947)	
SCF, WET (DRY)	1.000 (.978)		1.000 (.978)	
VOL (SCM)		337.2		338.1
SAM BLR (SCM)		77.40		77.49
KM (MEASURED)		11.59		11.92
FUEL CONSUMPTION L/100KM		10.09		9.28

COMPOSITE RESULTS

TEST NUMBER		448-A
BAROMETER	MM HG	735.3
HUMIDITY	G/KG	10.5
TEMPERATURE	DEG C	23.9

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	235.7	(234.4)
FUEL CONSUMPTION	L/100KM	9.68	(9.63)
HYDROCARBONS (THC)	G/KM	.11	(.11)
CARBON MONOXIDE	G/KM	.48	(.50)
OXIDES OF NITROGEN	G/KM	.83	(.82)

FTP VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 401-A RUN 1
VEHICLE MODEL 75 MERCEDES 240-D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 5/26/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-401-F
ODOMETER 13781. KM(8563. MILES)

BAROMETER 740.92 MM HG(29.17 IN HG)
RELATIVE HUMIDITY 60. PCT
DRY BULB TEMP. 21.7 DEG C(71.0 DEG F)
ABS. HUMIDITY 10.0 GM/KG

NOX HUMIDITY CORRECTION FACTOR .98

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	36.7 (98.0)	36.1 (97.0)	33.3 (92.0)	36.1 (97.0)
BLOWER REVOLUTIONS	12787.	21982.	12788.	21977.
TOT FLOW STD. CU. METRES(SCF)	126.0 (4447.)	216.8 (7656.)	127.0 (4484.)	216.7 (7653.)
HC SAMPLE METER/RANGE/PPM	12.7/11/ 13.	9.9/11/ 10.	11.2/11/ 11.	9.9/11/ 10.
HC BCKGRD METER/RANGE/PPM	4.9/ 1/ 5.	4.4/ 1/ 4.	4.4/ 1/ 4.	3.5/ 1/ 4.
CO SAMPLE METER/RANGE/PPM	23.0/13/ 21.	16.5/13/ 15.	20.9/13/ 19.	17.4/13/ 15.
CO BCKGRD METER/RANGE/PPM	1.1/13/ 1.	1.0/13/ 1.	.8/13/ 1.	1.0/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	39.0/ 3/ .66	25.2/ 3/ .41	35.5/ 3/ .59	25.7/ 3/ .42
CO2 BCKGRD METER/RANGE/PCT	2.8/ 3/ .04	3.1/ 3/ .05	3.0/ 3/ .05	3.1/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	21.1/ 2/ 21.	13.4/ 2/ 13.	19.4/ 2/ 19.	13.1/ 2/ 13.
NOX BCKGRD METER/RANGE/PPM	.8/ 2/ 1.	.5/ 2/ 1.	.7/ 2/ 1.	.4/ 2/ 0.
DILUTION FACTOR	20.23	32.41	22.42	31.73
HC CONCENTRATION PPM	8.	6.	7.	6.
CO CONCENTRATION PPM	19.	13.	17.	14.
CO2 CONCENTRATION PCT	.62	.37	.55	.37
NOX CONCENTRATION PPM	20.3	12.9	18.7	12.7
HC MASS GRAMS	.58	.70	.51	.81
CO MASS GRAMS	2.79	3.37	2.57	3.57
CO2 MASS GRAMS	1426.2	1449.2	1280.9	1483.4
NOX MASS GRAMS	4.79	5.23	4.45	5.15
HC GRAMS/KM	.10	.11	.09	.13
CO GRAMS/KM	.49	.54	.45	.58
CO2 GRAMS/KM	251.8	233.7	223.8	239.5
NOX GRAMS/KM	.85	.84	.78	.83
FUEL CONSUMPTION BY CB L/100KM	10.05	9.33	8.93	9.57
RUN TIME (SECONDS)	505.	868.	505.	868.
MEASURED DISTANCE (KM)	5.66	6.20	5.72	6.19
DFC, WET (DRY)	.962 (.944)		.964 (.945)	
SCF, WET (DRY)	1.000 (.976)		1.000 (.976)	
VOL (SCM)		342.8		343.7
SAM BLR (SCM)		77.76		77.69
KM (MEASURED).		11.86		11.92
FUEL CONSUMPTION L/100KM		9.67		9.26

COMPOSITE RESULTS

TEST NUMBER		401-A
BAROMETER	MM HG	740.9
HUMIDITY	G/KG	10.0
TEMPERATURE	DEG C	21.7

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	234.7	(236.4)
FUEL CONSUMPTION	L/100KM	9.37	(9.44)
HYDROCARBONS (THC)	G/KM	.10	(.11)
CARBON MONOXIDE	G/KM	.51	(.52)
OXIDES OF NITROGEN	G/KM	.83	(.82)

85KM/H VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 401-A RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 5/28/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-401-F
ODOMETER 13813. KM(8583. MILES)

BAROMETER 740.92 MM HG(29.17 IN HG)
RELATIVE HUMIDITY 61. PCT

DRY BULB TEMP. 22.8 DEG C(73.0 DEG F)
ABS. HUMIDITY 11.0 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.01

0 BAG RESULTS
TEST CYCLE

	85KM
BLOWER DIF P MM. H2O(IN. H2O)	609.6 (24.0)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	35.0 (95.0)
BLOWER REVOLUTIONS	30415.
TOT FLOW STD. CU. METRES(SCF)	300.0 (10594.)
HC SAMPLE METER/RANGE/PPM	17.1/11/ 17.
HC BCKGRD METER/RANGE/PPM	3.1/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	30.7/13/ 28.
CO BCKGRD METER/RANGE/PPM	.7/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	57.0/ 3/ 1.00
CO2 BCKGRD METER/RANGE/PCT	2.9/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	39.9/ 2/ 40.
NOX BCKGRD METER/RANGE/PPM	.4/ 2/ 0.
DILUTION FACTOR	13.29
HC CONCENTRATION PPM	14.
CO CONCENTRATION PPM	26.
CO2 CONCENTRATION PCT	.96
NOX CONCENTRATION PPM	39.5
HC MASS GRAMS	2.47
CO MASS GRAMS	9.14
CO2 MASS GRAMS	5287.5
NOX MASS GRAMS	22.86
RUN TIME SECONDS	1201.
DFC, WET (DRY)	.925 (.906)
SCF, WET (DRY)	1.000 (.971)
VOL (SCM)	300.0
SAM BLR (SCM)	67.75
KM (MEASURED)	27.86

TEST NUMBER,		401-A
BAROMETER,	MM HG	740.9
HUMIDITY,	G/KG	11.0
TEMPERATURE,	DEG C	22.8
CARBON DIOXIDE,	G/KM	189.8
FUEL CONSUMPTION,	L/100KM	7.57
HYDROCARBONS,	G/KM	.09
CARBON MONOXIDE,	G/KM	.33
OXIDES OF NITROGEN,	G/KM	.82

FTP VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 401-B RUN 1
VEHICLE MODEL 75 MERCEDES 240-D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 6/ 4/80
BAG CART NO. 1 / CVS NO. 3
DYNO NO. 2

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-401-F
ODOMETER 13950. KM(8668. MILES)

BAROMETER 741.93 MM HG(29.21 IN HG)
RELATIVE HUMIDITY 60. PCT
DRY BULB TEMP. 21.1 DEG C(70.0 DEG F)
ABS. HUMIDITY 9.6 GM/KG

NOX HUMIDITY CORRECTION FACTOR .96

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	37.8 (100.0)	35.6 (96.0)	36.7 (98.0)	37.8 (100.0)
BLOWER REVOLUTIONS	12756.	21986.	12773.	21972.
TOT FLOW STD. CU. METRES(SCF)	124.9 (4410.)	216.4 (7642.)	125.4 (4427.)	215.1 (7594.)
HC SAMPLE METER/RANGE/PPM	11.1/11/ 11.	8.4/11/ 8.	9.7/11/ 10.	8.3/11/ 8.
HC BCKGRD METER/RANGE/PPM	2.4/ 1/ 2.	2.6/ 1/ 3.	2.4/ 1/ 2.	2.4/ 1/ 2.
CO SAMPLE METER/RANGE/PPM	22.9/13/ 20.	15.7/13/ 14.	20.8/13/ 19.	17.0/13/ 15.
CO BCKGRD METER/RANGE/PPM	.7/13/ 1.	.9/13/ 1.	.8/13/ 1.	.8/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	41.6/ 3/ .71	26.0/ 3/ .43	36.5/ 3/ .61	26.0/ 3/ .43
CO2 BCKGRD METER/RANGE/PCT	3.3/ 3/ .05	3.2/ 3/ .05	3.0/ 3/ .05	3.0/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	24.1/ 2/ 24.	16.0/ 2/ 16.	22.3/ 2/ 22.	15.4/ 2/ 15.
NOX BCKGRD METER/RANGE/PPM	2.8/ 2/ 3.	2.6/ 2/ 3.	2.3/ 2/ 2.	2.1/ 2/ 2.
DILUTION FACTOR	18.86	31.36	21.76	31.36
HC CONCENTRATION PPM	9.	6.	7.	6.
CO CONCENTRATION PPM	19.	13.	17.	14.
CO2 CONCENTRATION PCT	.66	.30	.57	.38
NOX CONCENTRATION PPM	21.4	13.5	20.1	13.4
HC MASS GRAMS	.63	.74	.54	.74
CO MASS GRAMS	2.79	3.21	2.52	3.50
CO2 MASS GRAMS	1508.5	1496.3	1306.7	1498.7
NOX MASS GRAMS	4.94	5.38	4.65	5.30
HC GRAMS/KM	.11	.12	.09	.12
CO GRAMS/KM	.49	.52	.44	.56
CO2 GRAMS/KM	265.5	242.9	228.3	240.2
NOX GRAMS/KM	.87	.87	.81	.85
FUEL CONSUMPTION BY CB L/100KM	10.59	9.69	9.11	9.59
RUN TIME SECONDS	504.	868.	504.	868.
MEASURED DISTANCE KM	5.68	6.16	5.72	6.24
SCF, DRY	.974	.977	.975	.977
DFC, WET (DRY)	.960 (.942)		.963 (.944)	
SCF, WET (DRY)	1.000 (.976)		1.000 (.976)	
VOL (SCM)	341.3		340.4	
SAM BLR (SCM)	77.79		77.73	
KM (MEASURED)	11.84		11.96	
FUEL CONSUMPTION L/100KM	10.12		9.36	

COMPOSITE RESULTS

			3-BAG	(4-BAG)
TEST NUMBER		401-B		
BAROMETER	MM HG	741.9		
HUMIDITY	G/KG	9.6		
TEMPERATURE	DEG C	21.1		
CARBON DIOXIDE	G/KM		243.6	(242.8)
FUEL CONSUMPTION	L/100KM		9.72	(9.69)
HYDROCARBONS (THC)	G/KM		.11	(.11)
CARBON MONOXIDE	G/KM		.49	(.50)
OXIDES OF NITROGEN	G/KM		.86	(.85)

85KM/H VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 401-B RUN 1
VEHICLE MODEL 75 MERCEDES 240-D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 6/ 4/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-401-F
ODOMETER 13974. KM(8683. MILES)

BAROMETER 741.93 MM HG(29.21 IN HG)
RELATIVE HUMIDITY 58. PCT
DRY BULB TEMP. 22.8 DEG C(73.0 DEG F)
ABS. HUMIDITY 10.2 GM/KG

NOX HUMIDITY CORRECTION FACTOR .98

0 BAG RESULTS
TEST CYCLE

	85KM
BLOWER DIF P MM. H2O(IN. H2O)	609.6 (24.0)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	39.4 (103.0)
BLOWER REVOLUTIONS	30405.
TOT FLOW STD. CU. METRES(SCF)	295.5 (10436.)
HC SAMPLE METER/RANGE/PPM	16.2/11/ 16.
HC BCKGRD METER/RANGE/PPM	2.5/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	32.1/13/ 29.
CO BCKGRD METER/RANGE/PPM	.5/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	58.8/ 3/ 1.04
CO2 BCKGRD METER/RANGE/PCT	3.1/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	44.4/ 2/ 44.
NOX BCKGRD METER/RANGE/PPM	2.0/ 2/ 2.
DILUTION FACTOR	12.84
HC CONCENTRATION PPM	14.
CO CONCENTRATION PPM	28.
CO2 CONCENTRATION PCT	1.00
NOX CONCENTRATION PPM	42.6
HC MASS GRAMS	2.37
CO MASS GRAMS	9.51
CO2 MASS GRAMS	5385.9
NOX MASS GRAMS	23.68
RUN TIME SECONDS	1201.
DFC, WET (DRY)	.922 (.905)
SCF, WET (DRY)	1.000 (.972)
VOL (SCM)	295.5
SAM BLR (SCM)	66.14
KM (MEASURED)	27.69
TEST NUMBER,	401-B
BAROMETER, MM HG	741.9
HUMIDITY, G/KG	10.2
TEMPERATURE, DEG C	22.8
CARBON DIOXIDE, G/KM	194.5
FUEL CONSUMPTION, L/100KM	7.76
HYDROCARBONS, G/KM	.09
CARBON MONOXIDE, G/KM	.34
OXIDES OF NITROGEN, G/KM	.86

FTP VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 460-A RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 7/ 2/80
BAG CART NO. 1 / CVS NO. 3
DYNO NO. 2

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-460-F
ODOMETER 14093. KM(8757. MILES)

BAROMETER 740.41 MM HG(29.15 IN HG)
RELATIVE HUMIDITY 56. PCT
DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)
ABS. HUMIDITY 11.0 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.01

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	612.1 (24.1)	609.6 (24.0)	617.2 (24.3)	612.1 (24.1)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)	482.6 (19.0)	485.1 (19.1)	485.1 (19.1)
BLOWER INLET TEMP. DEG. C(DEG. F)	38.9 (102.0)	40.0 (104.0)	37.2 (99.0)	39.4 (103.0)
BLOWER REVOLUTIONS	12697.	21923.	12752.	21840.
TOT FLOW STD. CU. METRES(SCF)	124.5 (4395.)	214.2 (7562.)	125.3 (4426.)	213.7 (7544.)
HC SAMPLE METER/RANGE/PPM	12.8/11/ 13.	8.5/11/ 8.	9.8/11/ 10.	8.6/11/ 9.
HC BCKGRD METER/RANGE/PPM	2.5/ 1/ 3.	2.5/ 1/ 3.	2.5/ 1/ 3.	2.3/ 1/ 2.
CO SAMPLE METER/RANGE/PPM	24.7/13/ 22.	17.6/13/ 16.	20.7/13/ 18.	17.1/13/ 15.
CO BCKGRD METER/RANGE/PPM	.1/13/ 0.	.1/13/ 0.	.4/13/ 0.	.2/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	41.4/ 3/ .70	26.5/ 3/ .43	37.8/ 3/ .64	24.8/ 3/ .40
CO2 BCKGRD METER/RANGE/PCT	2.5/ 3/ .04	2.7/ 3/ .04	3.0/ 3/ .05	3.0/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	23.6/ 2/ 24.	14.6/ 2/ 15.	22.7/ 2/ 23.	14.3/ 2/ 14.
NOX BCKGRD METER/RANGE/PPM	.5/ 2/ 1.	.6/ 2/ 1.	.7/ 2/ 1.	.7/ 2/ 1.
DILUTION FACTOR	18.95	30.72	20.94	32.97
HC CONCENTRATION PPM	10.	6.	7.	6.
CO CONCENTRATION PPM	21.	15.	18.	15.
CO2 CONCENTRATION PCT	.67	.39	.59	.36
NOX CONCENTRATION PPM	23.1	14.0	22.0	13.6
HC MASS GRAMS	.75	.75	.53	.79
CO MASS GRAMS	3.09	3.76	2.56	3.63
CO2 MASS GRAMS	1521.4	1544.2	1361.5	1406.6
NOX MASS GRAMS	5.55	5.79	5.32	5.61
HC GRAMS/KM	.13	.12	.09	.13
CO GRAMS/KM	.54	.61	.45	.59
CO2 GRAMS/KM	265.8	250.4	238.1	228.1
NOX GRAMS/KM	.97	.94	.93	.91
FUEL CONSUMPTION BY CB L/100KM	10.35	9.75	9.27	8.89
RUN TIME SECONDS	505.	868.	505.	867.
MEASURED DISTANCE KM	5.72	6.17	5.72	6.17
SCF, DRY	.976	.978	.976	.978
DFC, WET (DRY)	.960 (.943)		.963 (.946)	
SCF, WET (DRY)	1.000 (.977)		1.000 (.978)	
VOL (SCM)	338.6		339.0	
SAM BLR (SCM)	77.37		77.24	
KM (MEASURED)	11.89		11.89	
FUEL CONSUMPTION L/100KM	10.04		9.07	

COMPOSITE RESULTS

TEST NUMBER		460-A
BAROMETER	MM HG	740.4
HUMIDITY	G/KG	11.0
TEMPERATURE	DEG C	24.4

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	250.2	(243.6)
FUEL CONSUMPTION	L/100KM	9.74	(9.49)
HYDROCARBONS (THC)	G/KM	.12	(.12)
CARBON MONOXIDE	G/KM	.55	(.54)
OXIDES OF NITROGEN	G/KM	.94	(.93)

FTP VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 460-E RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 7/10/80
BAG CART NO. 1 / CVS NO. 3
DYNO NO. 2

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-460-F
ODOMETER 14149. KM(8792. MILES)

DRY BULB TEMP. 25.6 DEG C(78.0 DEG F)
ABS. HUMIDITY 12.7 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.07

BAROMETER 742.44 MM HG(29.23 IN HG)
RELATIVE HUMIDITY 60. PCT

BAG RESULTS	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	614.7 (24.2)	614.7 (24.2)	614.7 (24.2)	614.7 (24.2)
BLOWER INLET P MM. H2O(IN. H2O)	487.7 (19.2)	487.7 (19.2)	487.7 (19.2)	487.7 (19.2)
BLOWER INLET TEMP. DEG. C(DEG. F)	38.6 (101.5)	38.3 (101.0)	37.2 (99.0)	38.6 (101.5)
BLOWER REVOLUTIONS	12781.	21985.	12791.	21960.
TOT FLOW STD. CU. METRES(SCF)	124.9 (4410.)	214.9 (7589.)	125.4 (4428.)	214.6 (7577.)
HC SAMPLE METER/RANGE/PPM	13.6/11/ 14.	9.6/11/ 10.	11.1/11/ 11.	9.8/11/ 10.
HC BCKGRD METER/RANGE/PPM	2.5/ 1/ 3.	2.5/ 1/ 3.	2.5/ 1/ 3.	2.8/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	28.4/13/ 26.	21.3/13/ 19.	24.1/13/ 22.	20.4/13/ 18.
CO BCKGRD METER/RANGE/PPM	1.1/13/ 1.	.6/13/ 1.	.4/13/ 0.	.5/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	40.2/ 3/ .68	26.3/ 3/ .43	35.6/ 3/ .60	25.4/ 3/ .41
CO2 BCKGRD METER/RANGE/PCT	3.1/ 3/ .05	2.7/ 3/ .04	2.9/ 3/ .04	3.0/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	21.0/ 2/ 21.	13.9/ 2/ 14.	19.9/ 2/ 20.	13.7/ 2/ 14.
NOX BCKGRD METER/RANGE/PPM	.8/ 2/ 1.	1.0/ 2/ 1.	.9/ 2/ 1.	1.0/ 2/ 1.
DILUTION FACTOR	19.55	30.94	22.34	32.11
HC CONCENTRATION PPM	11.	7.	9.	7.
CO CONCENTRATION PPM	24.	18.	21.	17.
CO2 CONCENTRATION PCT	.64	.39	.55	.37
NOX CONCENTRATION PPM	20.2	12.9	19.0	12.7
HC MASS GRAMS	.81	.89	.63	.88
CO MASS GRAMS	3.47	4.49	3.00	4.31
CO2 MASS GRAMS	1455.2	1536.0	1272.6	1454.0
NOX MASS GRAMS	5.17	5.68	4.88	5.58
HC GRAMS/KM	.14	.14	.11	.14
CO GRAMS/KM	.60	.72	.52	.69
CO2 GRAMS/KM	252.9	245.6	221.0	234.2
NOX GRAMS/KM	.90	.91	.85	.90
FUEL CONSUMPTION BY CB L/100KM	9.86	9.58	8.61	9.14
RUN TIME SECONDS	505.	868.	505.	868.
MEASURED DISTANCE KM	5.75	6.25	5.76	6.21
SCF, DRY	.974	.977	.975	.977
DFC, WET (DRY)	.961 (.942)		.964 (.945)	
SCF, WET (DRY)	1.000 (.976)		1.000 (.976)	
VOL (SCM)	339.8		340.0	
SAM BLR (SCM)	77.66		77.66	
KM (MEASURED)	12.01		11.97	
FUEL CONSUMPTION L/100KM	9.71		8.88	

COMPOSITE RESULTS

TEST NUMBER		460-E
BAROMETER	MM HG	742.4
HUMIDITY	G/KG	12.7
TEMPERATURE	DEG C	25.6

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	240.4	(237.0)
FUEL CONSUMPTION	L/100KM	9.37	(9.24)
HYDROCARBONS (THC)	G/KM	.13	(.13)
CARBON MONOXIDE	G/KM	.64	(.63)
OXIDES OF NITROGEN	G/KM	.89	(.89)

FTP VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 461-A RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 7/15/80
BAG CART NO. 1 / CVS NO. 3
DYNO NO. 2

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-461-F
ODOMETER 14186. KM(8815. MILES)

BAROMETER 743.20 MM HG(29.26 IN HG)
RELATIVE HUMIDITY 60. PCT
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)
ABS. HUMIDITY 12.1 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.05

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	614.7 (24.2)	609.6 (24.0)	622.3 (24.5)	619.8 (24.4)
BLOWER INLET P MM. H2O(IN. H2O)	487.7 (19.2)	485.1 (19.1)	487.7 (19.2)	487.7 (19.2)
BLOWER INLET TEMP. DEG. C(DEG. F)	38.1 (100.5)	38.6 (101.5)	38.1 (100.5)	37.8 (100.0)
BLOWER REVOLUTIONS	12751.	21985.	12761.	21766.
TOT FLOW STD. CU. METRES(SCF)	125.6 (4436.)	216.3 (7639.)	125.7 (4437.)	214.9 (7588.)
HC SAMPLE METER/RANGE/PPM	11.1/11/ 11.	8.4/11/ 8.	8.9/11/ 9.	7.5/11/ 7.
HC BCKGRD METER/RANGE/PPM	4.3/ 1/ 4.	3.9/ 1/ 4.	3.9/ 1/ 4.	3.4/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	22.8/13/ 20.	15.7/13/ 14.	20.2/13/ 18.	15.0/13/ 13.
CO BCKGRD METER/RANGE/PPM	1.6/13/ 1.	1.1/13/ 1.	.6/13/ 1.	.9/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	39.3/ 3/ .66	24.9/ 3/ .41	35.5/ 3/ .59	24.8/ 3/ .40
CO2 BCKGRD METER/RANGE/PCT	3.0/ 3/ .05	2.8/ 3/ .04	2.7/ 3/ .04	3.4/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	19.6/ 2/ 20.	13.7/ 2/ 14.	19.3/ 2/ 19.	13.6/ 2/ 14.
NOX BCKGRD METER/RANGE/PPM	1.1/ 2/ 1.	1.0/ 2/ 1.	.9/ 2/ 1.	.8/ 2/ 1.
DILUTION FACTOR	20.07	32.84	22.43	32.99
HC CONCENTRATION PPM	7.	5.	5.	4.
CO CONCENTRATION PPM	18.	13.	17.	12.
CO2 CONCENTRATION PCT	.62	.36	.56	.35
NOX CONCENTRATION PPM	18.6	12.7	18.4	12.8
HC MASS GRAMS	.51	.58	.37	.52
CO MASS GRAMS	2.69	3.17	2.48	3.03
CO2 MASS GRAMS	1428.6	1443.0	1277.7	1391.2
NOX MASS GRAMS	4.68	5.52	4.65	5.53
HC GRAMS/KM	.09	.09	.06	.08
CO GRAMS/KM	.47	.51	.43	.49
CO2 GRAMS/KM	250.9	234.2	223.5	225.2
NOX GRAMS/KM	.82	.90	.81	.89
FUEL CONSUMPTION BY CB L/100KM	10.21	9.54	9.10	9.17
RUN TIME SECONDS	504.	868.	504.	868.
MEASURED DISTANCE KM	5.69	6.16	5.72	6.18
SCF, DRY	.975	.977	.975	.977
DFC, WET (DRY)	.962 (.944)		.964 (.946)	
SCF, WET (DRY)	1.000 (.976)		1.000 (.976)	
VOL (SCM)	342.0		340.6	
SAM BLR (SCM)	77.79		77.63	
KM (MEASURED)	11.86		11.90	
FUEL CONSUMPTION L/100KM	9.86		9.13	

COMPOSITE RESULTS

TEST NUMBER		461-A
BAROMETER	MM HG	743.2
HUMIDITY	G/KG	12.1
TEMPERATURE	DEG C	25.0

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	234.7	(232.0)
FUEL CONSUMPTION	L/100KM	9.56	(9.45)
HYDROCARBONS (THC)	G/KM	.09	(.08)
CARBON MONOXIDE	G/KM	.48	(.48)
OXIDES OF NITROGEN	G/KM	.86	(.86)

FTP VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 461-B RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 7/23/80
BAG CART NO. 1 / CVS NO. 3
DYNO NO. 2

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-461-F
ODOMETER 14231. KM(8843. MILES)

BAROMETER 739.65 MM HG(29.12 IN HG)
RELATIVE HUMIDITY 57. PCT

DRY BULB TEMP. 25.6 DEG C(78.0 DEG F)
ABS. HUMIDITY 12.0 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.04

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	609.6 (24.0)	607.1 (23.9)	609.6 (24.0)	607.1 (23.9)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)	482.6 (19.0)	485.1 (19.1)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	37.8 (100.0)	38.6 (101.5)	38.3 (101.0)	37.5 (99.5)
BLOWER REVOLUTIONS	12767.	21965.	12781.	21639.
TOT FLOW STD. CU. METRES(SCF)	125.2 (4423.)	215.1 (7594.)	125.2 (4420.)	213.0 (7522.)
HC SAMPLE METER/RANGE/PPM	9.4/11/ 9.	6.7/11/ 7.	8.5/11/ 8.	6.9/11/ 7.
HC BCKGRD METER/RANGE/PPM	3.3/ 1/ 3.	3.0/ 1/ 3.	3.0/ 1/ 3.	2.8/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	22.1/13/ 20.	15.0/13/ 13.	18.9/13/ 17.	14.8/13/ 13.
CO BCKGRD METER/RANGE/PPM	.8/13/ 1.	.8/13/ 1.	.3/13/ 0.	.1/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	40.9/ 3/ .69	25.9/ 3/ .42	36.0/ 3/ .60	25.4/ 3/ .41
CO2 BCKGRD METER/RANGE/PCT	2.9/ 3/ .04	3.2/ 3/ .05	3.1/ 3/ .05	3.1/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	20.2/ 2/ 20.	14.0/ 2/ 14.	19.8/ 2/ 20.	14.3/ 2/ 14.
NOX BCKGRD METER/RANGE/PPM	.9/ 2/ 1.	1.1/ 2/ 1.	1.1/ 2/ 1.	1.4/ 2/ 1.
DILUTION FACTOR	19.22	31.51	22.10	32.17
HC CONCENTRATION PPM	6.	4.	6.	4.
CO CONCENTRATION PPM	18.	12.	16.	13.
CO2 CONCENTRATION PCT	.65	.38	.56	.37
NOX CONCENTRATION PPM	19.3	12.9	18.7	12.9
HC MASS GRAMS	.45	.47	.41	.51
CO MASS GRAMS	2.69	3.06	2.34	3.13
CO2 MASS GRAMS	1496.1	1479.9	1280.5	1437.5
NOX MASS GRAMS	4.83	5.55	4.68	5.50
HC GRAMS/KM	.08	.08	.07	.08
CO GRAMS/KM	.47	.49	.40	.50
CO2 GRAMS/KM	261.3	237.9	222.0	230.0
NOX GRAMS/KM	.84	.89	.81	.88
FUEL CONSUMPTION BY CB L/100KM	10.63	9.69	9.04	9.37
RUN TIME SECONDS	505.	868.	505.	867.
MEASURED DISTANCE KM	5.72	6.22	5.77	6.25
SCF, DRY	.975	.978	.976	.978
DFC, WET (DRY)	.961 (.943)		.964 (.946)	
SCF, WET (DRY)	1.000 (.977)		1.000 (.977)	
VOL (SCM)	340.3		338.2	
SAM BLR (SCM)	77.35		77.32	
KM (MEASURED)	11.95		12.02	
FUEL CONSUMPTION L/100KM	10.14		9.21	

COMPOSITE RESULTS

TEST NUMBER		461-B
BAROMETER	MM HG	739.6
HUMIDITY	G/KG	12.0
TEMPERATURE	DEG C	25.6

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	238.4	(236.1)
FUEL CONSUMPTION	L/100KM	9.70	(9.61)
HYDROCARBONS (THC)	G/KM	.07	(.08)
CARBON MONOXIDE	G/KM	.46	(.47)
OXIDES OF NITROGEN	G/KM	.86	(.86)

FTP VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 395-B RUN 4
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 8/ 7/80
BAG CART NO. 1 / CVS NO. 3
DYNO NO. 2

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-395-F
ODOMETER 14342. KM(8912. MILES)

BAROMETER 742.70 MM HG(29.24 IN HG)
RELATIVE HUMIDITY 53. PCT
DRY BULB TEMP. 25.6 DEG C(78.0 DEG F)
ABS. HUMIDITY 11.2 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.01

BAG RESULTS	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	614.7 (24.2)	614.7 (24.2)	614.7 (24.2)	614.7 (24.2)
BLOWER INLET P MM. H2O(IN. H2O)	487.7 (19.2)	482.6 (19.0)	487.7 (19.2)	487.7 (19.2)
BLOWER INLET TEMP. DEG. C(DEG. F)	37.2 (99.0)	35.6 (96.0)	37.2 (99.0)	37.8 (100.0)
BLOWER REVOLUTIONS	12640.	21057.	12790.	21057.
TOT FLOW STD. CU. METRES(SCF)	124.9 (4410.)	210.3 (7426.)	126.1 (4454.)	209.2 (7388.)
HC SAMPLE METER/RANGE/PPM	11.6/11/ 12.	8.2/11/ 8.	10.1/11/ 10.	8.6/11/ 9.
HC BCKGRD METER/RANGE/PPM	4.0/ 1/ 4.	3.8/ 1/ 4.	3.8/ 1/ 4.	3.3/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	24.8/13/ 22.	17.7/13/ 16.	21.7/13/ 19.	17.3/13/ 15.
CO BCKGRD METER/RANGE/PPM	1.0/13/ 1.	.9/13/ 1.	.6/13/ 1.	.4/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	39.7/ 3/ .67	25.3/ 3/ .41	34.9/ 3/ .58	23.9/ 3/ .39
CO2 BCKGRD METER/RANGE/PCT	3.1/ 3/ .05	2.5/ 3/ .04	2.2/ 3/ .03	2.3/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	19.5/ 2/ 20.	13.0/ 2/ 13.	19.7/ 2/ 20.	13.7/ 2/ 14.
NOX BCKGRD METER/RANGE/PPM	.5/ 2/ 1.	.7/ 2/ 1.	.5/ 2/ 1.	.9/ 2/ 1.
DILUTION FACTOR	19.84	32.28	22.84	34.28
HC CONCENTRATION PPM	8.	5.	6.	5.
CO CONCENTRATION PPM	21.	15.	18.	15.
CO2 CONCENTRATION PCT	.63	.38	.55	.35
NOX CONCENTRATION PPM	19.0	12.3	19.2	12.8
HC MASS GRAMS	.56	.55	.47	.65
CO MASS GRAMS	3.02	3.56	2.69	3.56
CO2 MASS GRAMS	1433.8	1447.0	1274.4	1357.6
NOX MASS GRAMS	4.61	5.03	4.71	5.21
HC GRAMS/KM	.10	.09	.08	.11
CO GRAMS/KM	.53	.58	.47	.58
CO2 GRAMS/KM	252.0	235.2	224.4	221.0
NOX GRAMS/KM	.81	.82	.83	.85
FUEL CONSUMPTION BY CB L/100KM	10.24	9.56	9.12	8.99
RUN TIME SECONDS	505.	860.	505.	868.
MEASURED DISTANCE KM	5.69	6.15	5.68	6.14
SCF, DRY	.977	.979	.977	.979
DFC, WET (DRY)	.962 (.945)		.965 (.949)	
SCF, WET (DRY)	1.000 (.978)		1.000 (.979)	
VOL (SCM)	335.2		335.4	
SAM BLR (SCM)	77.57		77.74	
KM (MEASURED)	11.84		11.82	
FUEL CONSUMPTION L/100KM	9.89		9.05	

COMPOSITE RESULTS

TEST NUMBER		395-B
BAROMETER	MM HG	742.7
HUMIDITY	G/KG	11.2
TEMPERATURE	DEG C	25.6

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	235.8	(231.5)
FUEL CONSUMPTION	L/100KM	9.58	(9.41)
HYDROCARBONS (THC)	G/KM	.09	(.09)
CARBON MONOXIDE	G/KM	.54	(.54)
OXIDES OF NITROGEN	G/KM	.82	(.83)

85KM/H VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 395-B RUN 4
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 8/ 7/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-395-F
ODOMETER 14381. KM(8936. MILES)

BAROMETER 741.17 MM HG(29.18 IN HG)
RELATIVE HUMIDITY 57. PCT

DRY BULB TEMP. 25.6 DEG C(78.0 DEG F)
ABS. HUMIDITY 11.9 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.04

0 BAG RESULTS

TEST CYCLE		85KM
BLOWER DIF P MM. H2O(IN. H2O)		584.2 (23.0)
BLOWER INLET P MM. H2O(IN. H2O)		477.5 (18.8)
BLOWER INLET TEMP. DEG. C(DEG. F)		46.1 (115.0)
BLOWER REVOLUTIONS		29700.
TOT FLOW STD. CU. METRES(SCF)		287.5 (10150.)
HC SAMPLE METER/RANGE/PPM		17.9/11/ 18.
HC BCKGRD METER/RANGE/PPM		3.3/ 1/ 3.
CO SAMPLE METER/RANGE/PPM		36.3/13/ 33.
CO BCKGRD METER/RANGE/PPM		.8/13/ 1.
CO2 SAMPLE METER/RANGE/PCT		60.4/ 3/ 1.07
CO2 BCKGRD METER/RANGE/PCT		3.0/ 3/ .05
NOX SAMPLE METER/RANGE/PPM		43.4/ 2/ 43.
NOX BCKGRD METER/RANGE/PPM		.9/ 2/ 1.
DILUTION FACTOR		12.45
HC CONCENTRATION PPM		15.
CO CONCENTRATION PPM		31.
CO2 CONCENTRATION PCT		1.03
NOX CONCENTRATION PPM		42.6
HC MASS GRAMS		2.46
CO MASS GRAMS		10.48
CO2 MASS GRAMS		5413.9
NOX MASS GRAMS		24.38
RUN TIME	SECONDS	1198.
DFC, WET (DRY)		.920 (.903)
SCF, WET (DRY)		1.000 (.972)
VOL (SCM)		287.5
SAM BLR (SCM)		67.15
KM (MEASURED)		27.87
TEST NUMBER,		395-B
BAROMETER,	MM HG	741.2
HUMIDITY,	G/KG	11.9
TEMPERATURE,	DEG C	25.6
CARBON DIOXIDE,	G/KM	194.3
FUEL CONSUMPTION,	L/100KM	7.89
HYDROCARBONS,	G/KM	.09
CARBON MONOXIDE,	G/KM	.38
OXIDES OF NITROGEN,	G/KM	.87

FTP VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 395-A RUN 3
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 8/12/80
BAG CART NO. 1 / CVS NO. 3
DYNO NO. 2

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-395-F
ODOMETER 14421. KM(8961. MILES)

BAROMETER 741.93 MM HG(29.21 IN HG)
RELATIVE HUMIDITY 62. PCT
DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)
ABS. HUMIDITY 11.4 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.02

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	609.6 (24.0)	622.3 (24.5)	622.3 (24.5)	622.3 (24.5)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	37.2 (99.0)	36.1 (97.0)	37.2 (99.0)	35.6 (96.0)
BLOWER REVOLUTIONS	12787.	21979.	12796.	21962.
TOT FLOW STD. CU. METRES(SCF)	125.9 (4446.)	216.9 (7659.)	125.9 (4447.)	217.0 (7663.)
HC SAMPLE METER/RANGE/PPM	10.4/11/ 10.	7.0/11/ 7.	9.5/11/ 9.	8.0/11/ 8.
HC BCKGRD METER/RANGE/PPM	3.2/ 1/ 3.	3.3/ 1/ 3.	3.3/ 1/ 3.	3.3/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	24.2/13/ 22.	16.5/13/ 15.	21.2/13/ 19.	17.0/13/ 15.
CO BCKGRD METER/RANGE/PPM	.2/13/ 0.	.2/13/ 0.	.4/13/ 0.	.5/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	40.0/ 3/ .68	24.7/ 3/ .40	35.6/ 3/ .60	24.8/ 3/ .40
CO2 BCKGRD METER/RANGE/PCT	3.0/ 3/ .05	2.6/ 3/ .04	2.9/ 3/ .04	2.9/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	19.9/ 2/ 20.	12.8/ 2/ 13.	19.2/ 2/ 19.	12.8/ 2/ 13.
NOX BCKGRD METER/RANGE/PPM	.5/ 2/ 1.	.9/ 2/ 1.	.8/ 2/ 1.	.9/ 2/ 1.
DILUTION FACTOR	19.68	33.13	22.35	32.97
HC CONCENTRATION PPM	7.	4.	6.	5.
CO CONCENTRATION PPM	21.	14.	18.	14.
CO2 CONCENTRATION PCT	.63	.36	.55	.36
NOX CONCENTRATION PPM	19.4	11.9	18.4	11.9
HC MASS GRAMS	.53	.48	.46	.60
CO MASS GRAMS	3.05	3.54	2.63	3.59
CO2 MASS GRAMS	1461.7	1445.0	1278.0	1434.7
NOX MASS GRAMS	4.79	5.06	4.54	5.07
HC GRAMS/KM	.09	.08	.08	.10
CO GRAMS/KM	.53	.57	.46	.58
CO2 GRAMS/KM	253.2	232.9	222.6	232.5
NOX GRAMS/KM	.83	.82	.79	.82
FUEL CONSUMPTION BY CB L/100KM	10.29	9.47	9.04	9.45
RUN TIME SECONDS	505.	868.	505.	867.
MEASURED DISTANCE KM	5.77	6.20	5.74	6.17
SCF, DRY	.974	.976	.974	.976
DFC, WET (DRY)	.962 (.943)		.964 (.945)	
SCF, WET (DRY)	1.000 (.975)		1.000 (.976)	
VOL (SCM)	342.8		342.9	
SAM BLR (SCM)	77.42		77.35	
KM (MEASURED)	11.98		11.91	
FUEL CONSUMPTION L/100KM	9.86		9.26	

COMPOSITE RESULTS

TEST NUMBER		395-A
BAROMETER	MM HG	741.9
HUMIDITY	G/KG	11.4
TEMPERATURE	DEG C	23.3

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	234.3	(234.2)
FUEL CONSUMPTION	L/100KM	9.52	(9.52)
HYDROCARBONS (THC)	G/KM	.08	(.09)
CARBON MONOXIDE	G/KM	.53	(.53)
OXIDES OF NITROGEN	G/KM	.81	(.81)

FTP VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

WAIT
TEST NO. 463-A RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 8/14/80
BAG CART NO. 1 / CVS NO. 3
DYNO NO. 2

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-463-F
ODOMETER 14471. KM(8992. MILES)

BAROMETER 740.16 MM HG(29.14 IN HG)
RELATIVE HUMIDITY 66. PCT
DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)
ABS. HUMIDITY 12.2 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.05

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	COLD TRANSIENT	STABILIZED	HOT TRANSIENT	STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	622.3 (24.5)	622.3 (24.5)	622.3 (24.5)	622.3 (24.5)
BLOWER INLET P MM. H2O(IN. H2O)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	38.3 (101.0)	37.2 (99.0)	37.2 (99.0)	36.7 (98.0)
BLOWER REVOLUTIONS	12771.	21975.	12795.	21966.
TOT FLOW STD. CU. METRES(SCF)	125.1 (4416.)	215.8 (7619.)	125.6 (4435.)	216.0 (7625.)
HC SAMPLE METER/RANGE/PPM	14.6/11/ 15.	10.5/11/ 11.	10.8/11/ 11.	9.9/11/ 10.
HC BCKGRD METER/RANGE/PPM	4.2/ 1/ 4.	3.2/ 1/ 3.	3.2/ 1/ 3.	3.2/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	28.4/13/ 26.	20.8/13/ 19.	25.6/13/ 23.	22.0/13/ 20.
CO BCKGRD METER/RANGE/PPM	.6/13/ 1.	.4/13/ 0.	.3/13/ 0.	.6/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	42.3/ 3/ .72	26.6/ 3/ .44	38.2/ 3/ .64	27.1/ 3/ .44
CO2 BCKGRD METER/RANGE/PCT	2.8/ 3/ .04	3.0/ 3/ .05	2.9/ 3/ .04	2.9/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	24.4/ 2/ 24.	15.4/ 2/ 15.	24.2/ 2/ 24.	16.4/ 2/ 16.
NOX BCKGRD METER/RANGE/PPM	.7/ 2/ 1.	.7/ 2/ 1.	.7/ 2/ 1.	.9/ 2/ 1.
DILUTION FACTOR	18.49	30.57	20.69	29.96
HC CONCENTRATION PPM	11.	7.	8.	7.
CO CONCENTRATION PPM	24.	18.	22.	19.
CO2 CONCENTRATION PCT	.68	.39	.60	.40
NOX CONCENTRATION PPM	23.7	14.7	23.5	15.5
HC MASS GRAMS	.77	.92	.56	.85
CO MASS GRAMS	3.53	4.43	3.21	4.66
CO2 MASS GRAMS	1557.5	1545.2	1384.9	1587.2
NOX MASS GRAMS	5.96	6.38	5.94	6.74
HC GRAMS/KM	.13	.15	.09	.13
CO GRAMS/KM	.61	.71	.54	.73
CO2 GRAMS/KM	267.6	246.4	235.0	246.9
NOX GRAMS/KM	1.02	1.02	1.01	1.05
FUEL CONSUMPTION BY CB L/100KM	10.30	9.50	9.04	9.52
RUN TIME SECONDS	504.	868.	505.	868.
MEASURED DISTANCE KM	5.82	6.27	5.89	6.43
SCF, DRY	.972	.975	.973	.975
DFC, WET (DRY)	.959 (.939)		.961 (.941)	
SCF, WET (DRY)	1.000 (.974)		1.000 (.974)	
VOL (SCM)	340.8		341.6	
SAM BLR (SCM)	77.40		77.37	
KM (MEASURED)	12.09		12.32	
FUEL CONSUMPTION L/100KM	9.89		9.29	

COMPOSITE RESULTS

TEST NUMBER		463-A
BAROMETER	MM HG	740.2
HUMIDITY	G/KG	12.2
TEMPERATURE	DEG C	23.3

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	247.6	(247.8)
FUEL CONSUMPTION	L/100KM	9.54	(9.55)
HYDROCARBONS (THC)	G/KM	.13	(.13)
CARBON MONOXIDE	G/KM	.64	(.65)
OXIDES OF NITROGEN	G/KM	1.02	(1.03)

FTP VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 463-B RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M5

VEHICLE NO.1
DATE 8/20/80
BAG CART NO. 1 / CVS NO. 3
DYNO NO. 2

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-463-F
ODOMETER 14510. KM(9016. MILES)

BAROMETER 741.17 MM HG(29.18 IN HG)
RELATIVE HUMIDITY 65. PCT

DRY BULB TEMP. 26.7 DEG C(80.0 DEG F)
ABS. HUMIDITY 14.6 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.15

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	604.5 (23.8)	609.6 (24.0)	609.6 (24.0)	609.6 (24.0)
BLOWER INLET P MM. H2O(IN. H2O)	477.5 (18.8)	482.6 (19.0)	482.6 (19.0)	482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	38.9 (102.0)	37.8 (100.0)	39.4 (103.0)	37.8 (100.0)
BLOWER REVOLUTIONS	12794.	21945.	12787.	21959.
TOT FLOW STD. CU. METRES(SCF)	125.4 (4429.)	215.6 (7613.)	125.1 (4417.)	215.7 (7616.)
HC SAMPLE METER/RANGE/PPM	13.7/11/ 14.	9.7/11/ 10.	11.4/11/ 11.	10.3/11/ 10.
HC BCKGRD METER/RANGE/PPM	4.0/ 1/ 4.	3.5/ 1/ 4.	3.5/ 1/ 4.	3.2/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	30.0/13/ 27.	22.1/13/ 20.	26.5/13/ 24.	21.8/13/ 19.
CO BCKGRD METER/RANGE/PPM	2.0/13/ 2.	1.3/13/ 1.	.7/13/ 1.	.8/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	41.0/ 3/ .70	26.9/ 3/ .44	37.4/ 3/ .63	25.9/ 3/ .42
CO2 BCKGRD METER/RANGE/PCT	3.1/ 3/ .05	3.3/ 3/ .05	3.2/ 3/ .05	3.1/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	23.5/ 2/ 24.	15.6/ 2/ 16.	22.6/ 2/ 23.	15.2/ 2/ 15.
NOX BCKGRD METER/RANGE/PPM	1.6/ 2/ 2.	1.6/ 2/ 2.	1.2/ 2/ 1.	1.1/ 2/ 1.
DILUTION FACTOR	19.13	30.20	21.17	31.44
HC CONCENTRATION PPM	10.	6.	8.	7.
CO CONCENTRATION PPM	25.	18.	22.	18.
CO2 CONCENTRATION PCT	.65	.39	.58	.38
NOX CONCENTRATION PPM	22.0	14.1	21.5	14.1
HC MASS GRAMS	.71	.78	.58	.90
CO MASS GRAMS	3.59	4.53	3.27	4.57
CO2 MASS GRAMS	1495.9	1547.2	1335.3	1490.2
NOX MASS GRAMS	6.05	6.64	5.88	6.68
HC GRAMS/KM	.13	.13	.10	.15
CO GRAMS/KM	.64	.75	.58	.75
CO2 GRAMS/KM	264.7	254.7	236.5	244.0
NOX GRAMS/KM	1.07	1.09	1.04	1.09
FUEL CONSUMPTION BY CB L/100KM	10.19	9.82	9.11	9.41
RUN TIME SECONDS	505.	867.	505.	867.
MEASURED DISTANCE KM	5.65	6.07	5.65	6.11
SCF, DRY	.973	.975	.973	.975
DFC, WET (DRY)	.960 (.940)		.963 (.942)	
SCF, WET (DRY)	1.000 (.974)		1.000 (.975)	
VOL (SCM)	341.0		340.8	
SAM BLR (SCM)	78.27		78.20	
KM (MEASURED)	11.73		11.75	
FUEL CONSUMPTION L/100KM	10.00		9.26	

COMPOSITE RESULTS

TEST NUMBER		463-B
BAROMETER	MM HG	741.2
HUMIDITY	G/KG	14.6
TEMPERATURE	DEG C	26.7

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	251.8	(248.6)
FUEL CONSUMPTION	L/100KM	9.70	(9.58)
HYDROCARBONS (THC)	G/KM	.12	(.13)
CARBON MONOXIDE	G/KM	.68	(.68)
OXIDES OF NITROGEN	G/KM	1.07	(1.07)

APPENDIX E

SMOKE AND PARTICULATE EMISSIONS DATA

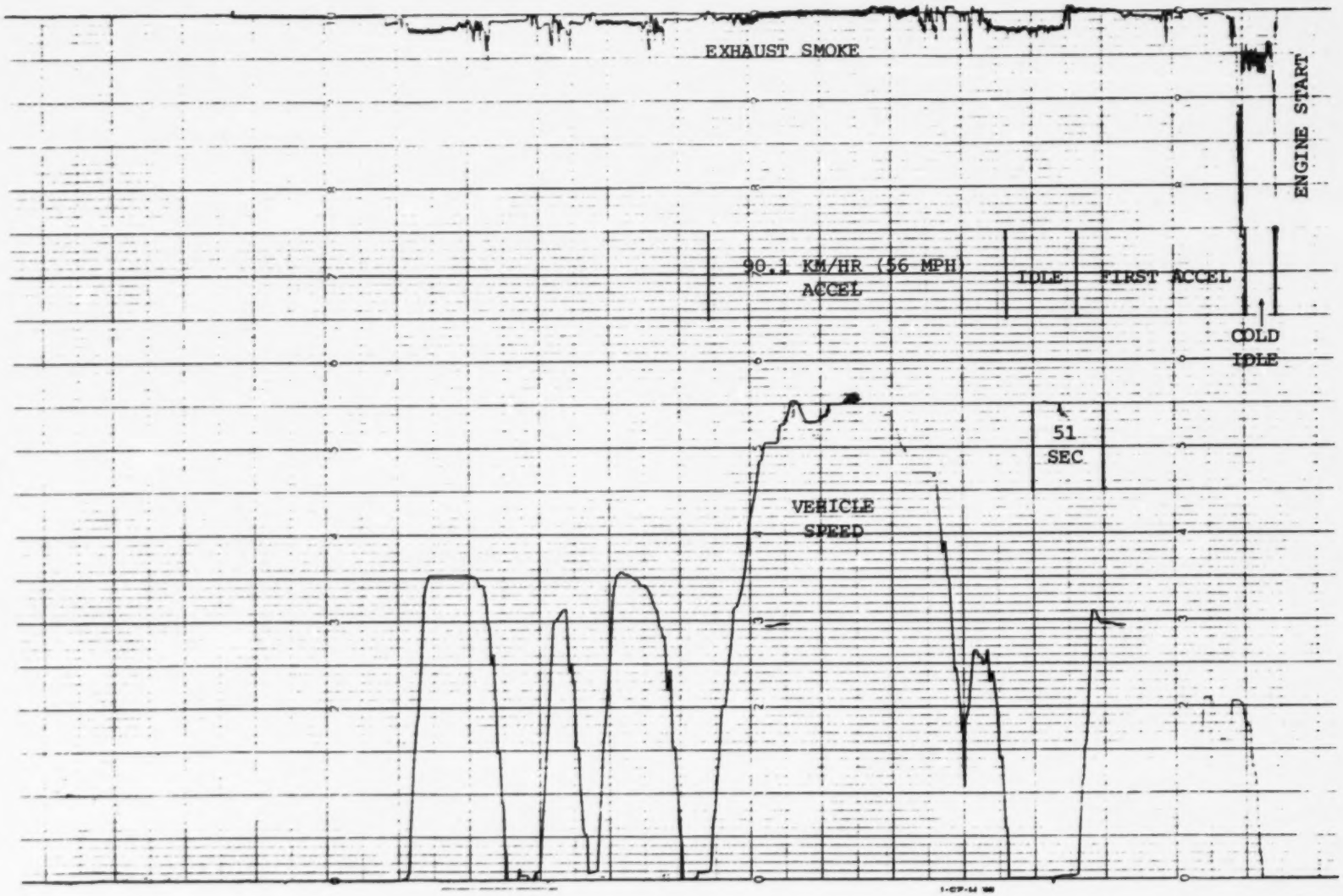


Figure E-1. Cold start smoke trace, fuel EM-395-F.

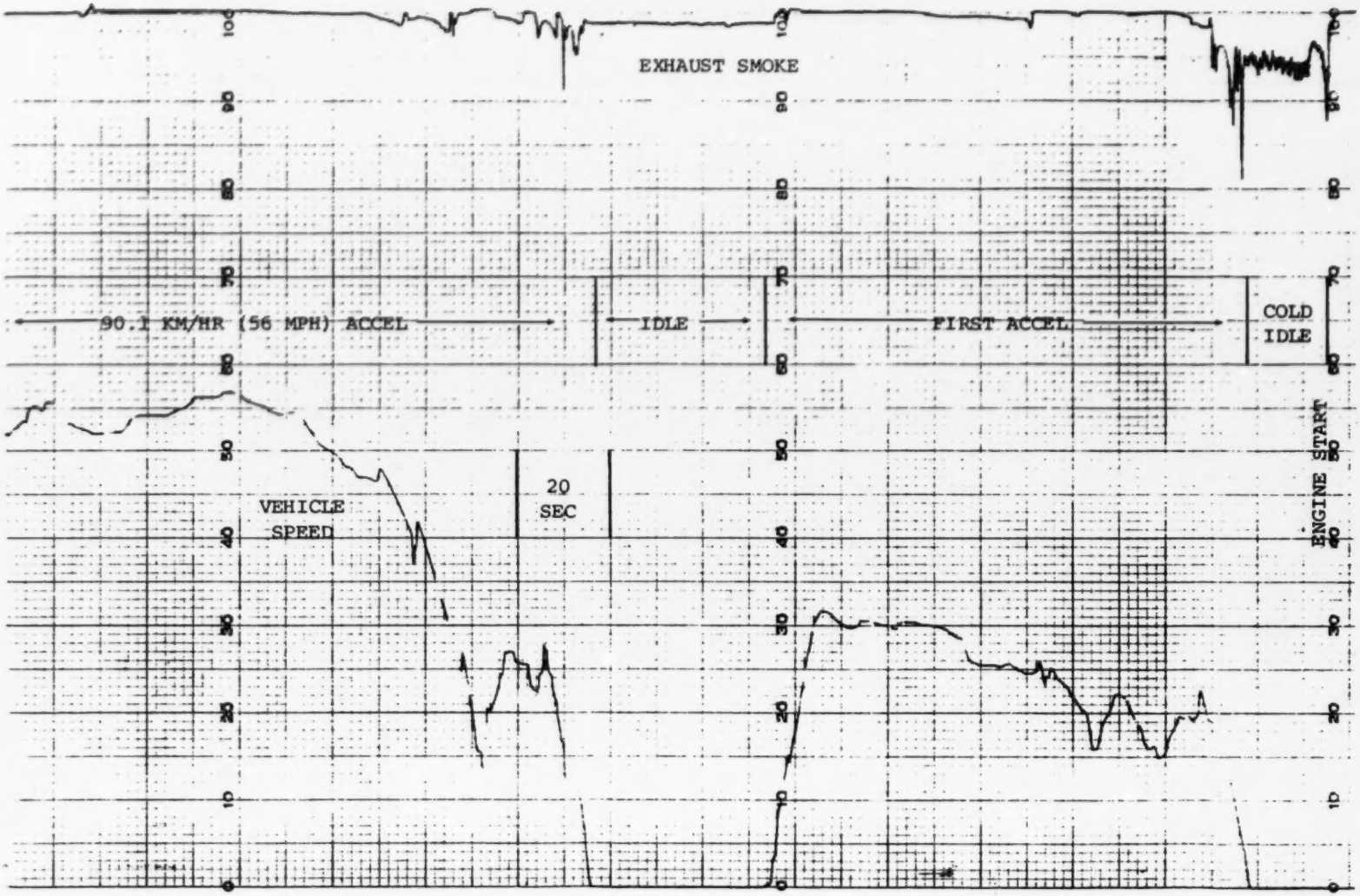


Figure E-2. Cold start smoke trace, fuel EM-401-F.

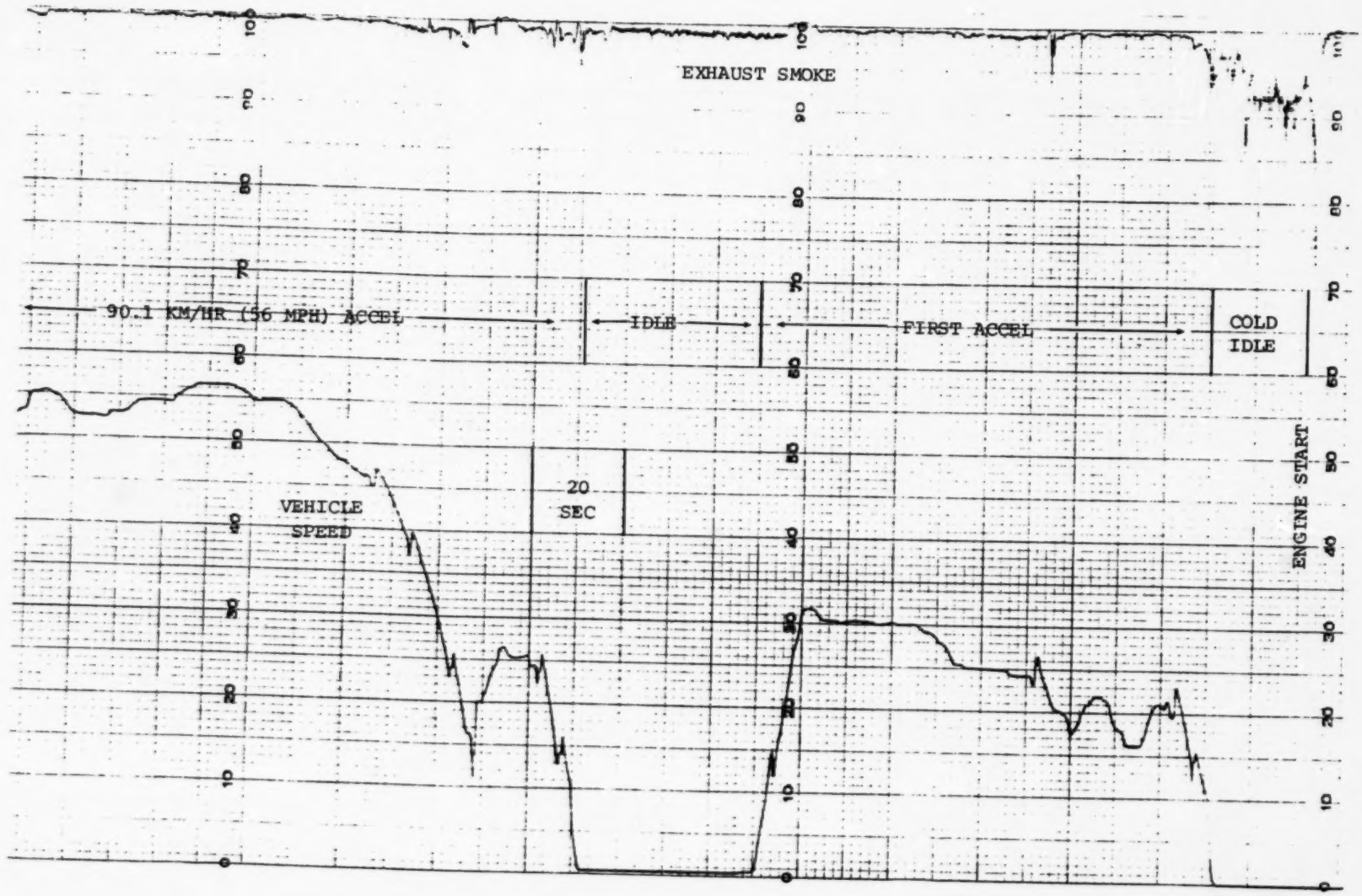


Figure E-3. Cold start smoke trace, fuel EM-404-F.

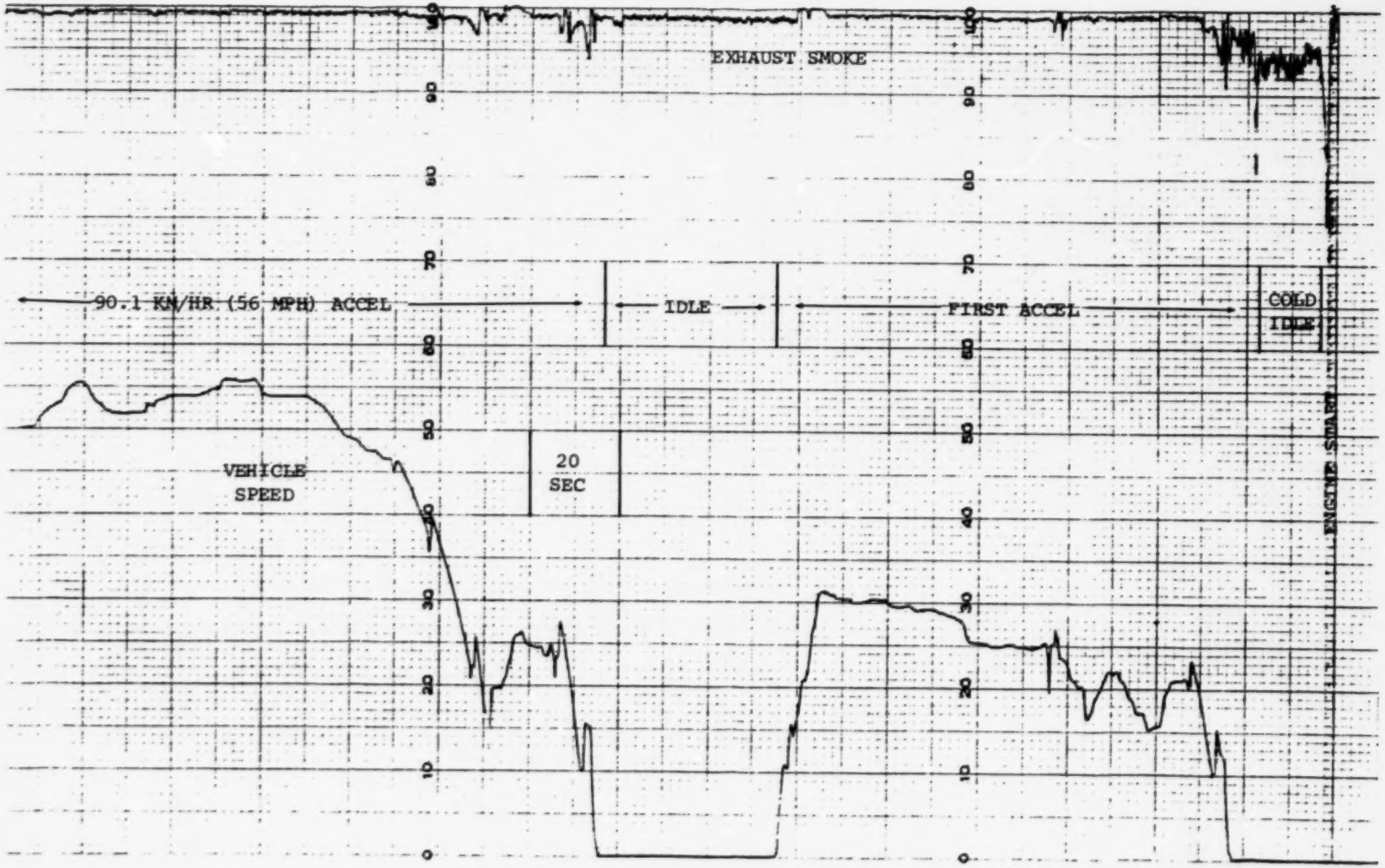


Figure E-4. Cold start smoke trace, fuel EM-405-F.

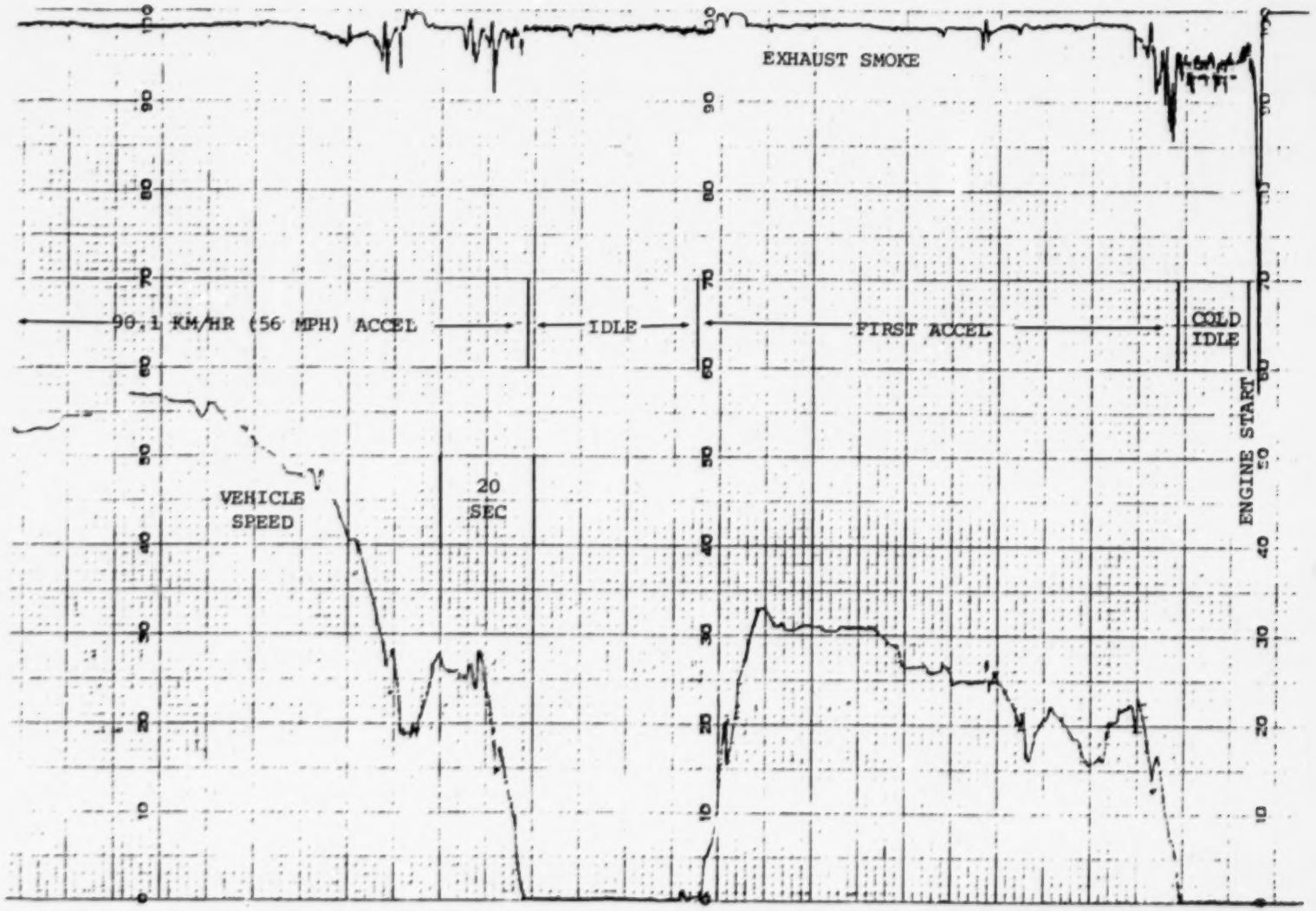


Figure E-5. Cold start smoke trace, fuel EM-434-F.

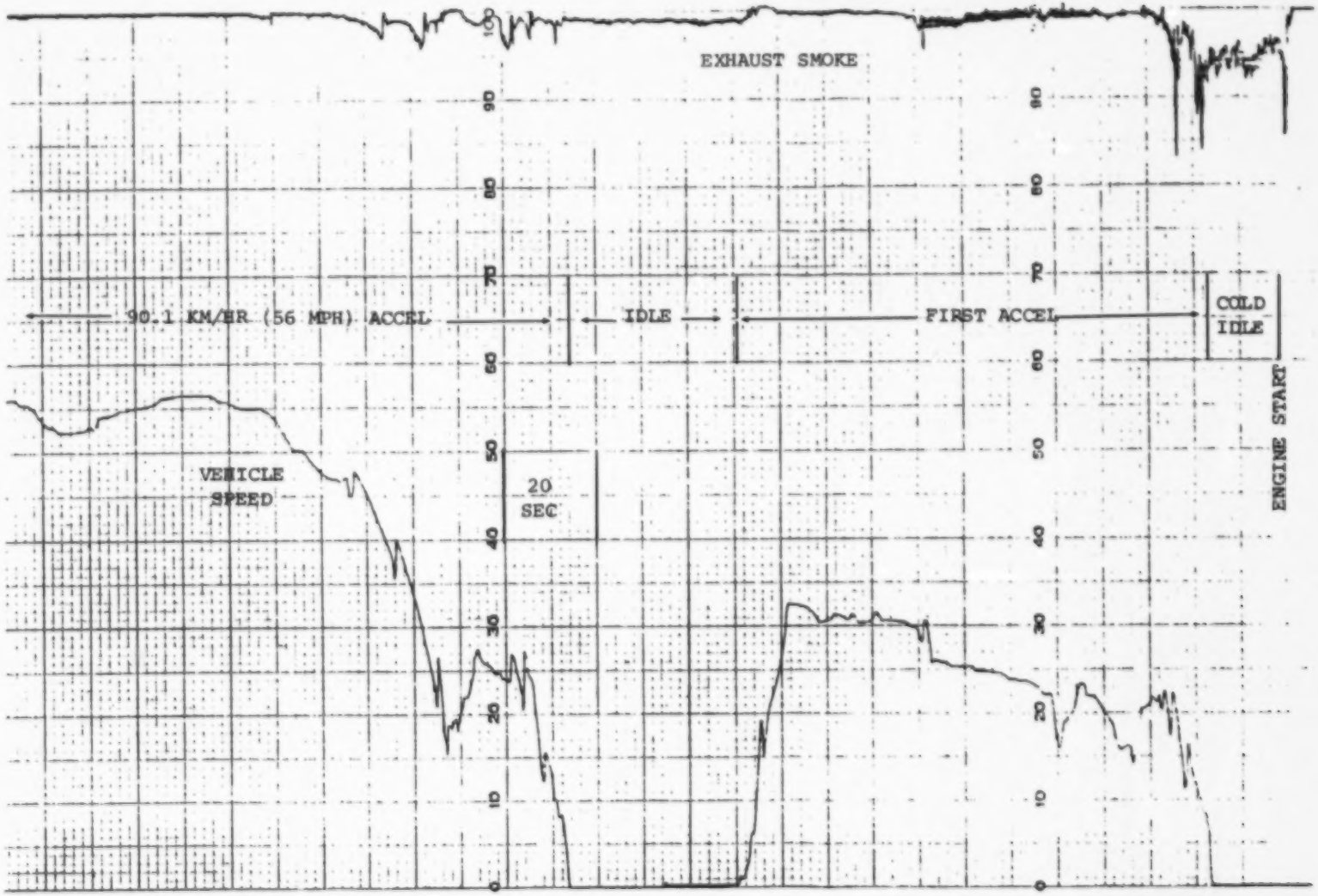


Figure E-6. Cold start smoke trace, fuel EM-438-F.

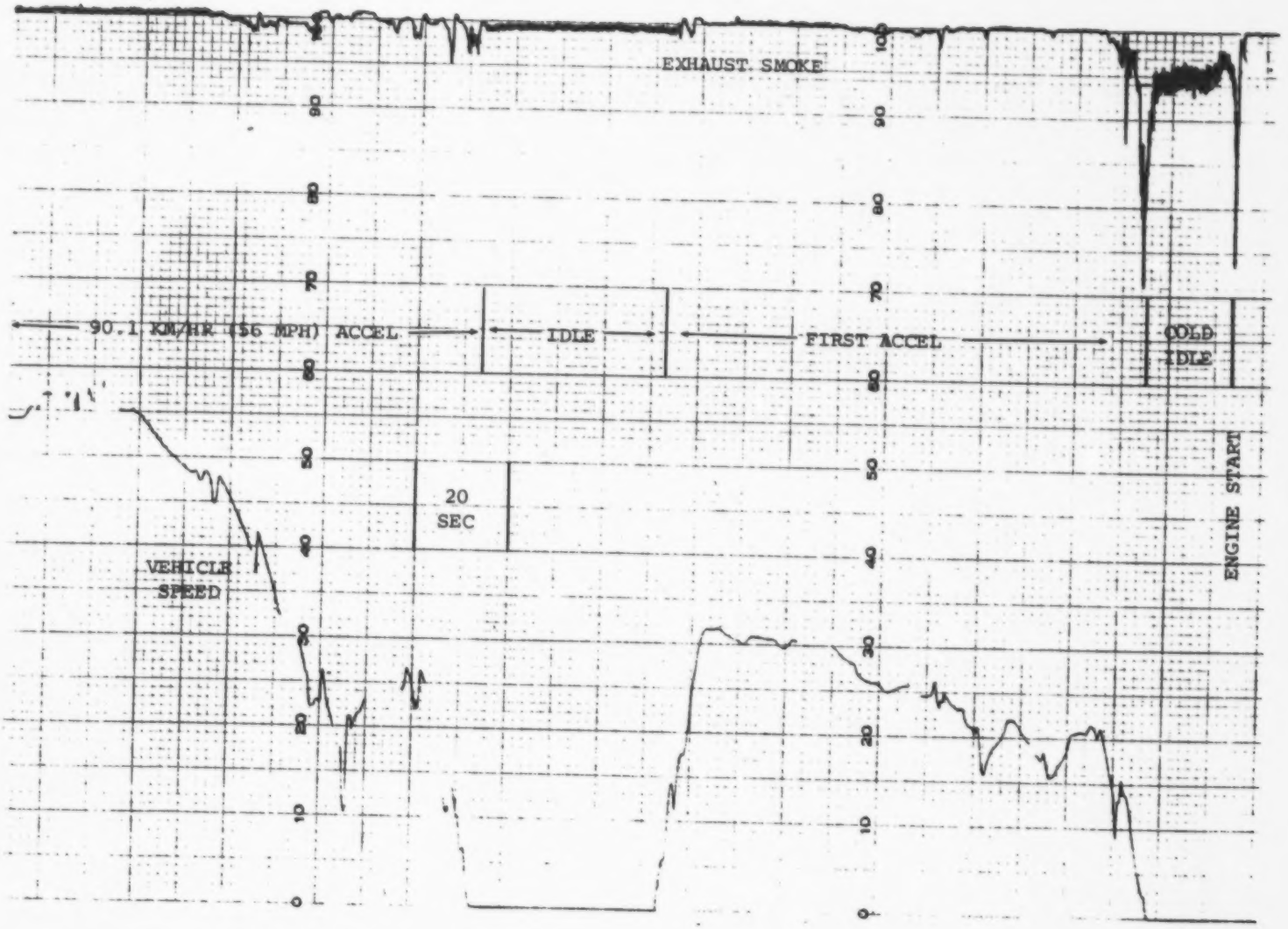


Figure E-7. Cold start smoke trace, fuel EM-448-F.

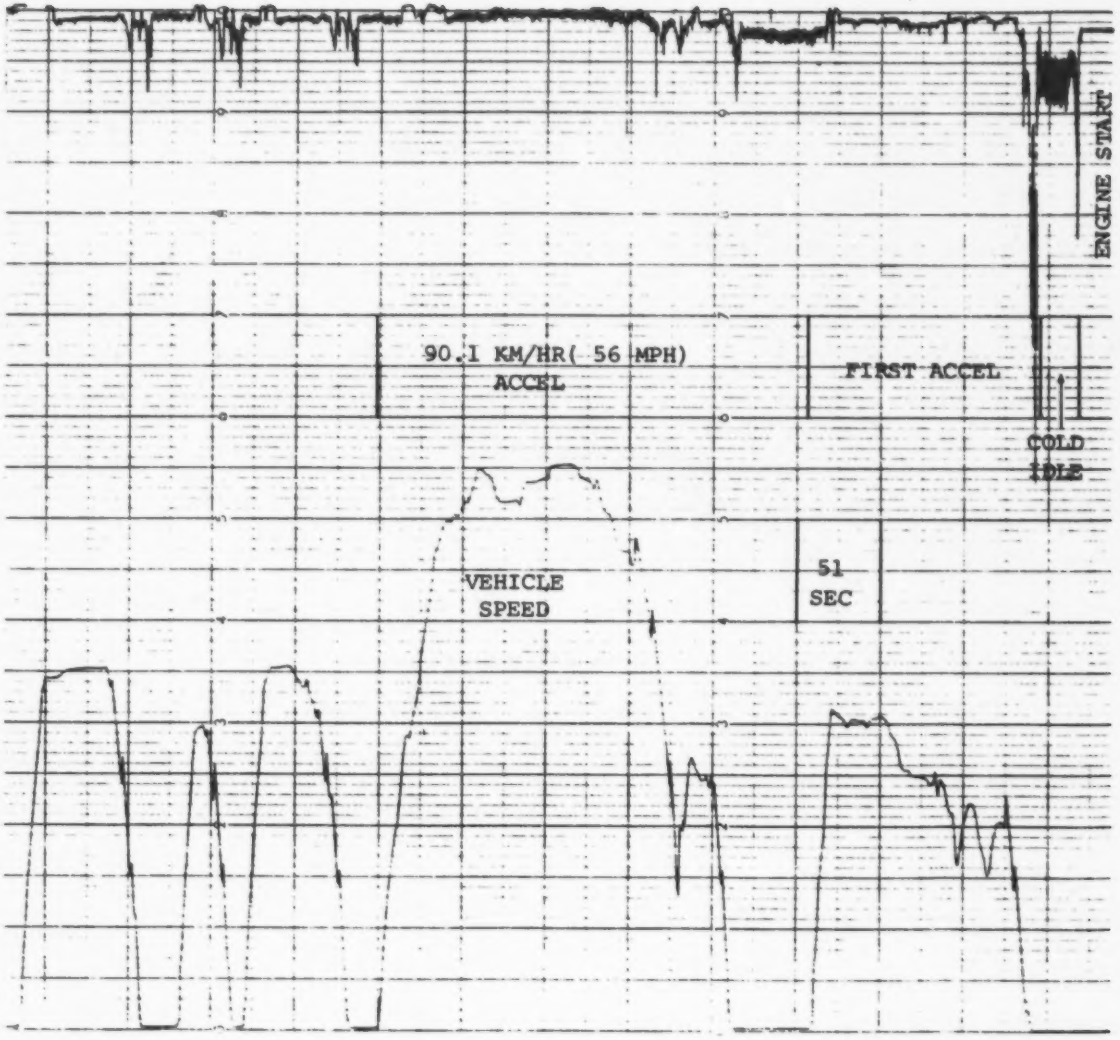


Figure E-8. Cold start smoke trace, fuel EM-460-F.

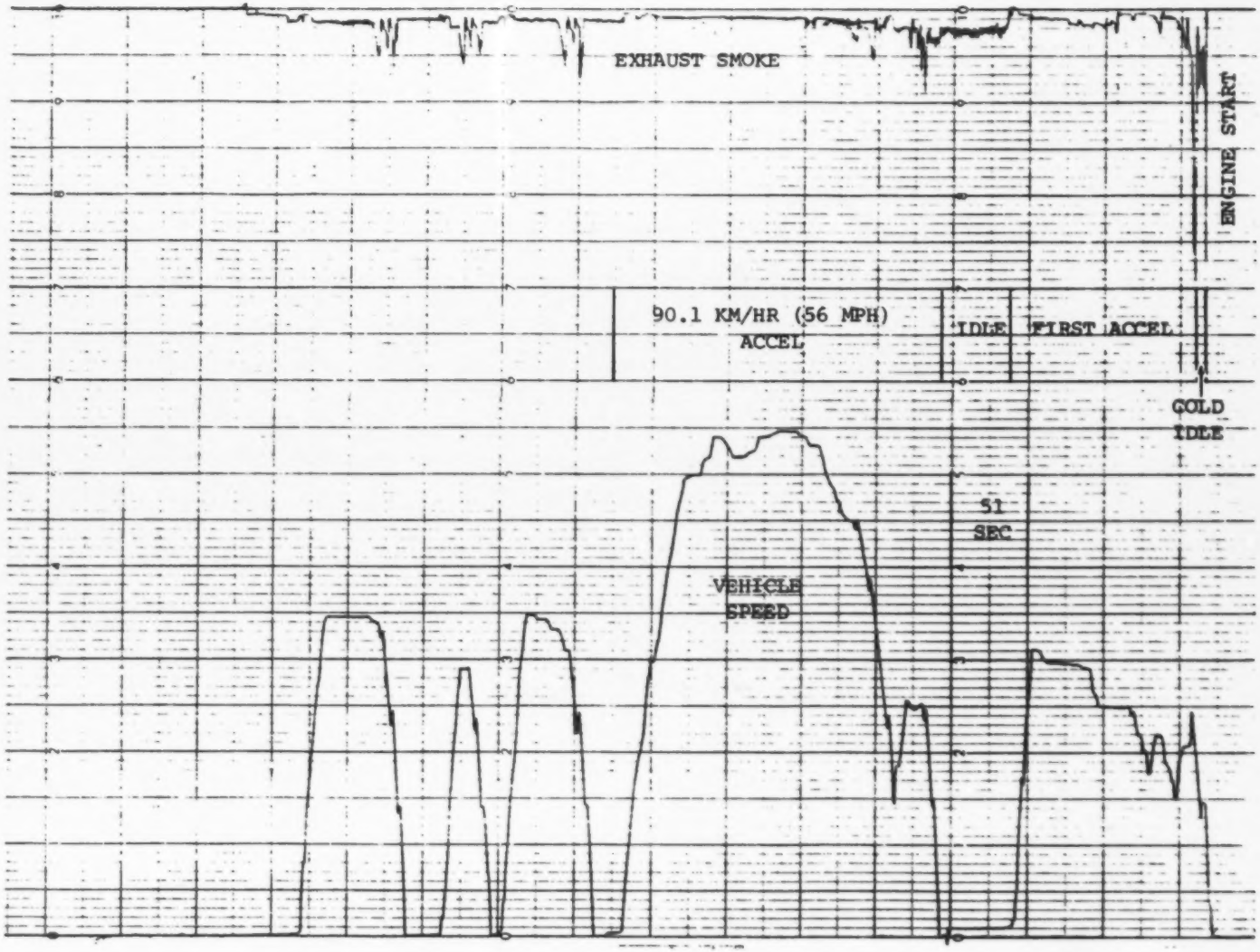


Figure E-9. Cold start smoke trace, fuel EM-461-F.

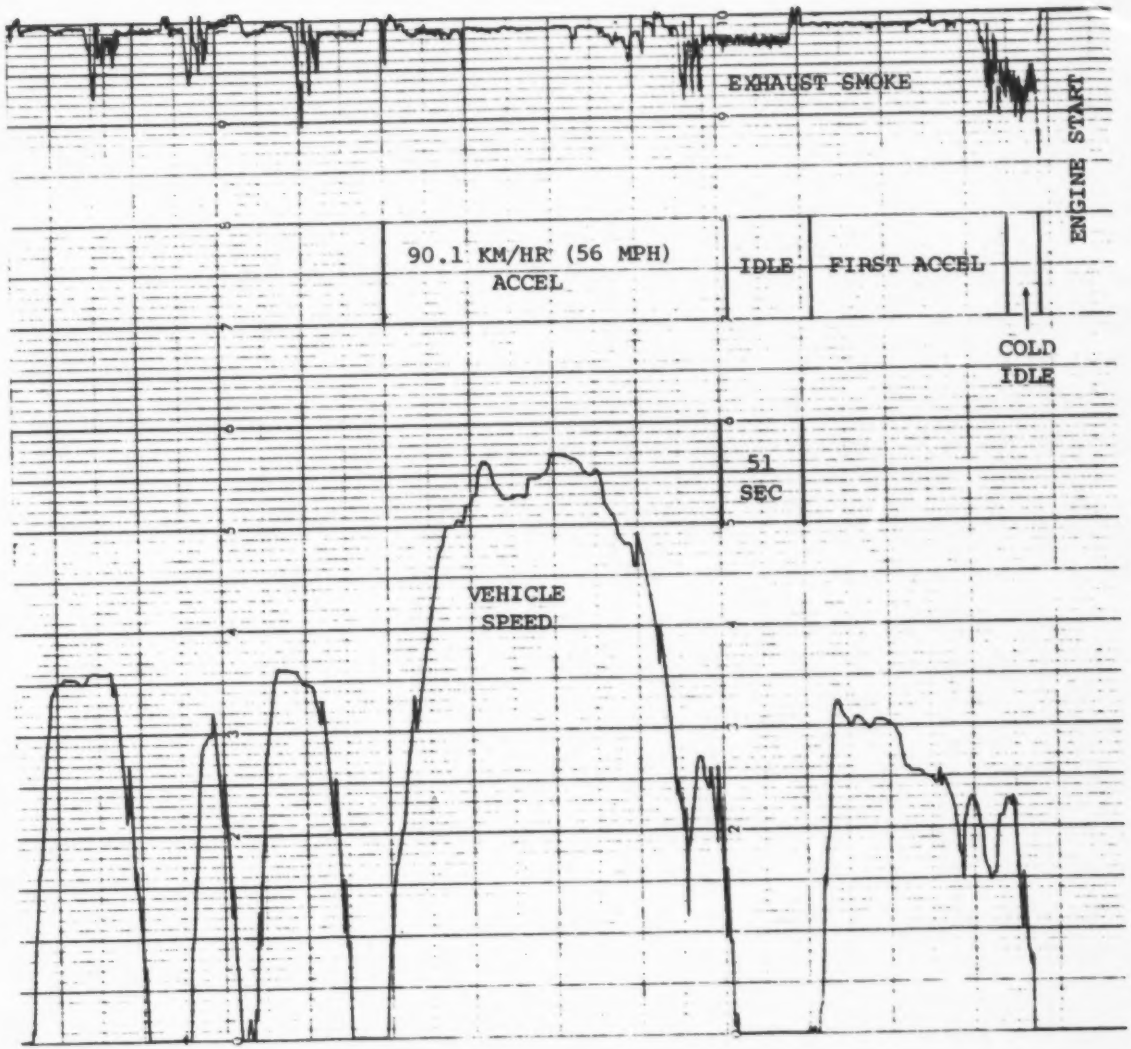


Figure E-10. Cold start smoke trace, EM-463-F.

PARTICLE SIZE DISTRIBUTION DURING COLD AND HOT FTP

Fuel Code EM-	Cumulative Percent of Total Particulate									Vehicle Total Particulate, g[b]
	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8	Stage 9	Stage 10	Filter	
	6.6 µm[a]	4.1 µm	2.6 µm	1.1 µm	0.85 µm	0.54 µm	0.34 µm	0.08 µm		
395-F	100.000	97.727	94.960	92.058	87.827	83.817	79.944	74.873	68.264	4.014
404-F	100.000	99.845	99.845	97.836	97.836	91.190	87.481	85.626	80.835	4.108
405-F	99.999	99.351	99.027	99.027	94.165	89.303	86.224	84.279	81.523	4.306
430-F	100.026	96.643	92.843	87.560	81.854	75.624	70.763	67.593	62.942	4.451
434-F	100.011	100.011	98.618	97.534	89.791	89.791	82.199	71.827	59.443	5.214
438-F	100.001	100.001	97.023	93.261	87.775	83.073	79.938	75.549	69.906	3.891
448-F	100.000	97.228	96.040	89.505	88.119	82.574	78.218	75.050	66.535	2.990
401-F	100.001	98.283	98.283	94.657	92.749	89.886	88.359	83.588	77.481	3.627
460-F	99.805	98.553	98.457	96.916	96.531	96.242	91.714	87.090	77.938	5.212
461-F	100.000	100.000	96.269	93.844	92.911	90.112	88.993	86.194	85.821	3.821
463-F	99.990	97.949	95.997	94.584	87.520	86.892	85.165	82.653	80.926	6.763
Average	99.985	98.690	97.033	94.253	90.643	87.137	83.545	79.484	73.783	4.399
V max.	100.026	100.011	99.845	99.027	97.836	96.242	91.714	87.090	85.821	6.763
V min.	99.805	96.643	92.843	89.505	81.854	75.624	70.763	67.593	59.443	2.990
S.D.	0.060	1.222	2.061	3.565	4.676	5.554	6.037	6.685	8.704	1.016
Range	0.221	3.368	7.002	9.522	15.982	20.618	20.951	19.497	26.378	3.773
Vari.	0.060	1.238	2.123	3.782	5.159	6.374	7.226	8.410	11.798	23.102

[a] Effective cutoff diameter
[b] Based on 47 mm Pallflex

PARTICULATE ANALYSES

Test No.	Fuel	Cycle	Particulate					Organic Soluble Portion of Particulate						
			Percent				Total Vehicle Particulate[a] g/test	Percent					Vehicle Total Solubles, g/test[a]	% of Total Particulate
			Carbon	Hydrogen	Nitrogen	Oxygen		Carbon	Hydrogen	Nitrogen	Sulfur	Oxygen		
395-A, 1	EM-395-F	FTP_c	76.5	5.3	0.19	--	2.15	--	--	--	--	--	--	--
		FTP_h	88.3	6.6	0.23	--	1.82	--	--	--	--	--	--	--
395-B, 1	EM-395-F	FTP_c	87.2	5.5	0.27	--	2.05	73.8	9.1	2.57	0.91	10.9	0.355	17.3
		FTP_h	90.0	6.6	0.26	--	2.10	74.4	9.5	1.13	0.52	13.6	0.300	14.3
		85 km/h	80.4	6.8	0.25	--	2.88	77.9	10.4	<0.5	0.53	7.8	0.792	27.5
395-B, 2	EM-395-F	85 km/h	77.9	7.0	0.23	--	2.92	76.9	9.6	1.65	0.75	10.9	0.990	33.9
404-A,1	EM-404-F	FTP_c	84.9	4.9	<0.10	--	2.04	--	--	--	--	--	--	--
		FTP_h	91.4	5.9	<0.10	--	1.76	--	--	--	--	--	--	--
404-E, 1	EM-404-F	FTP_c	87.0	5.1	<0.10	--	2.06	78.5	10.8	0.70	0.32	8.2	0.268	13.0
		FTP_h	84.4	5.2	<0.10	--	2.00	74.5	9.9	1.02	0.32	--	0.274	13.7
405-A, 1	EM-405-F	FTP_c	82.0	6.0	<0.10	--	2.18	74.9	10.4	0.75	0.37	--	0.251	11.5
		FTP_h	86.1	4.9	<0.10	--	1.88	83.7	12.8	1.00	0.38	--	0.182	9.7
405-B, 1	EM-404-F	FTP_c	87.0	4.8	<0.10	--	1.89	--	--	--	--	--	--	--
		FTP_h	88.0	5.1	<0.10	--	1.73	--	--	--	--	--	--	--
		85 km/h	84.8	6.5	<0.10	--	2.43	84.5	13.1	1.35	0.73	--	0.708	28.9
430-A, 1	EM-430-F	FTP_c	79.7	2.5	0.26	--	2.53	--	--	--	--	--	--	--
		FTP_h	80.3	2.6	0.13	25.4	1.93	--	--	--	--	--	--	--
395-A, 2	EM-395-F	FTP_c	94.8	3.2	0.20	26.4	2.26	--	--	--	--	--	--	--
		FTP_h	94.9	3.2	0.24	23.5	1.81	--	--	--	--	--	--	--
395-E, 1	EM-395-F	FTP_c	--	--	--	--	2.11	74.7	9.3	0.70	1.64	--	0.291	13.8
		FTP_h	--	--	--	--	1.83	74.1	9.6	0.72	1.28	7.9	0.313	17.1
434-A, 1	EM-434-F	FTP_c	--	3.7	0.68	--	2.59	--	--	--	--	--	--	--
		FTP_h	78.5	2.2	0.37	--	2.64	--	--	--	--	--	--	--
434-B, 1	EM-434-F	FTP_c	84.0	1.8	0.27	--	1.76	72.0	8.5	1.30	1.64	12.3	0.225	12.8
		FTP_h	--	--	--	--	2.63	71.4	8.5	1.45	0.44	13.0	0.345	13.1
		85 km/h	85.8	2.9	0.35	--	3.69	73.6	9.0	1.13	1.26	13.0	0.705	19.1
434-D, 1	EM-434-F	85 km/h	--	--	--	--	5.18	77.8	10.7	0.73	0.58	4.7	0.710	13.7
434-D, 2	EM-434-F	85 km/h	84.4	2.3	0.29	--	4.97	--	--	--	--	--	--	--

[a] Based on 47 mm Pallflex filter rate

PARTICULATE ANALYSES (Cont'd).

Test No.	Fuel	Cycle	Particulate					Organic Soluble Portion of Particulate						
			Percent				Total Vehicle Particulate g/test[a]	Percent					Vehicle Total Solubles, g/test[a]	% of Total Particulate
			Carbon	Hydrogen	Nitrogen	Oxygen		Carbon	Hydrogen	Nitrogen	Sulfur	Oxygen		
438-A, 1	EM-438-F	FTP_c	77.8	5.7	0.49	24.3	1.96	--	--	--	--	--	--	--
		FTP_h	75.6	6.0	0.94	22.7	1.93	--	--	--	--	--	--	--
438-E, 1	EM-438-F	FTP_c	84.3	6.5	0.45	17.2	1.88	74.5	9.4	1.35	0.66	13.1	0.331	17.6
		FTP_h	78.8	6.2	0.45	22.2	1.68	75.9	10.0	1.32	0.67	12.6	0.316	18.8
448-A, 1	EM-448-F	FTP_c	94.0	4.1	0.70	4.6	2.11	73.0	9.1	0.97	0.58	14.7	0.388	18.4
		FTP_h	75.2	3.1	0.39	15.7	1.70	76.6	10.6	1.63	0.62	9.1	0.325	19.1
448-A, 2	EM-448-F	FTP_c	97.5	3.3	0.53	24.8	1.53	--	--	--	--	--	--	--
		FTP_h	77.9	2.7	0.51	31.7	1.45	--	--	--	--	--	--	--
401-A, 1	EM-401-F	FTP_c	91.9	3.0	0.46	4.8	1.85	--	--	--	--	--	--	--
		FTP_h	74.2	2.9	0.35	18.2	1.77	--	--	--	--	--	--	--
		85 km/h	86.0	5.2	0.40	9.6	2.53	--	--	--	--	--	--	--
401-B, 1	EM-401-F	FTP_c	78.6	2.1	0.39	--	1.92	80.1	11.5	1.02	0.51	5.7	0.265	13.8
		FTP_h	73.5	2.3	0.34	--	1.67	78.3	11.1	1.39	0.51	7.0	0.286	17.1
		85 km/h	79.3	4.2	0.35	--	2.22	74.6	9.0	1.56	0.75	11.5	0.693	31.2
460-A, 1	EM-460-F	FTP_c	87.6	2.0	0.32	25.9	2.77	--	--	--	--	--	--	--
		FTP_h	80.4	2.1	0.25	22.2	2.44	--	--	--	--	--	--	--
460-E, 1	EM-460-F	FTP_c	84.3	2.1	0.31	--	2.58	82.1	12.0	0.23	0.40	--	0.333	12.9
		FTP_h	87.6	2.0	0.32	--	2.52	82.6	12.2	0.21	0.39	5.5	0.363	14.4
461-A, 1	EM-461-F	FTP_c	85.0	2.3	0.44	23.5	2.03	83.0	12.3	0.20	0.43	4.3	0.337	16.6
		FTP_h	76.6	2.4	0.30	31.4	1.80	82.4	12.5	0.25	0.45	5.1	0.297	16.5
461-B, 1	EM-461-F	FTP_c	80.3	2.4	0.36	27.2	2.07	--	--	--	--	--	--	--
		FTP_h	75.9	2.4	0.28	27.1	1.79	--	--	--	--	--	--	--
395-B, 4	EM-395-F	FTP_c	81.8	2.3	0.33	14.4	2.11	82.9	12.6	0.21	0.46	4.4	0.321	15.2
		FTP_h	85.3	2.5	0.29	30.9	2.07	83.3	12.5	0.25	0.46	3.9	0.379	18.3
		85 km/h	73.4	3.8	0.30	19.0	2.74	82.1	12.0	0.29	0.51	6.3	0.789	28.8
395-A, 3	EM-395-F	FTP_c	88.6	2.3	0.40	--	2.21	83.0	12.6	0.21	0.49	4.7	0.287	13.0
		FTP_h	--	--	--	--	2.08	--	--	--	--	--	0.345	16.6
463-A, 1	EM-463-F	FTP_c	82.9	1.5	0.27	17.8	3.41	--	--	--	--	--	--	--
		FTP_h	82.7	1.5	0.25	15.2	3.54	--	--	--	--	--	--	--
463-B, 1	EM-463-F	FTP_c	--	--	--	--	3.38	82.8	12.4	0.23	0.44	4.3	0.402	11.9
		FTP_h	--	--	--	--	3.38	81.7	12.3	0.25	0.55	5.5	0.412	12.2

[a] Based on 47 mm Pallflex filter rate

PERCENT TRACE ELEMENTS IN PARTICULATE MATTER

Fuel	EM-395-F			EM-404-F		EM-405-F			EM-430-F	
Cycle	FTP_c	FTP_h	85 km/hr	FTP_c	FTP_h	FTP_c	FTP_h	85 km/hr	FTP_c	FTP_h
Elements, pct										
Na	0.0099	0.0140	0.0231	0.0156	0.0000	0.0112	0.0145	0.0282	--	0.0000
Mg	0.0254	0.0176	0.0188	0.0289	0.0208	0.0280	0.0205	0.0192	--	0.0286
Al	0.0155	0.0074	0.0014	0.0211	0.0115	0.0184	0.0094	0.0000	--	0.0464
Si	0.0317	0.0221	0.0082	0.0469	0.0354	0.0344	0.0291	0.0051	--	0.0810
P	0.0641	0.0544	0.0981	0.0688	0.0635	0.0664	0.0564	0.0788	--	0.0750
S	0.3070	0.2176	0.2620	0.3773	0.2490	0.4424	0.2342	0.2423	--	0.5548
Cl	0.0148	0.0118	0.0072	0.0102	0.0000	0.0128	0.0513	0.0000	--	0.0083
Ca	0.1275	0.0706	0.0899	0.1359	0.0917	0.1280	0.0761	0.0763	--	0.1643
Ti	0.0028	0.0007	0.0000	0.0039	0.0021	0.0032	0.0000	0.0000	--	0.0155
Fe	0.7810	0.3309	0.0389	0.7094	0.3729	1.8144	0.6923	0.1269	--	0.9929
Zn	0.0803	0.0647	0.1221	0.0820	0.0813	0.1104	0.0829	0.1276	--	0.0905
Sn	0.0000	0.0051	0.0000	0.0070	0.0000	0.0000	0.0068	0.0109	--	0.0000
Ba	0.0000	0.0000	0.0000	0.0047	0.0000	0.0000	0.0000	0.0000	--	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	--	0.0000
Pb	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	--	0.0000
Mn	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	--	0.0000
Br	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	--	0.0000
Cd	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	--	0.0000
K	0.0014	0.0000	0.0024	0.0031	0.0000	0.0024	0.0000	0.0000	--	0.0060
Cu	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	--	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	--	0.0000
V	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	--	0.0000
Sb	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	--	0.0000
Total Percent of Particulate	1.4614	0.8169	0.6721	1.5148	0.9282	2.6720	1.2735	0.7153	--	2.0633
Total Vehicle Particulate, g/test[a]	2.24	1.97	3.11	2.04	1.90	2.23	1.98	2.45	--	1.93

[a] based on data from 47 mm Pallflex filter data

PERCENT TRACE ELEMENTS IN PARTICULATE MATTER (CONT'D)

Fuel	EM-434-F			EM-438-F		EM-448-F		EM-401-F		
Cycle	FTP_c	FTP_h	85 km/hr	FTP_c	FTP_h	FTP_c	FTP_h	FTP_c	FTP_h	85 km/hr
Elements, pct										
Na	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Mg	0.0081	0.0178	0.0076	0.0165	0.0000	0.0207	0.0045	0.0196	0.0173	0.0141
Al	0.0129	0.0145	0.0000	0.0137	0.0017	0.0221	0.0105	0.0187	0.0135	0.0047
Si	0.0264	0.0355	0.0123	0.0261	0.0000	0.0318	0.0331	0.0299	0.0289	0.0055
P	0.0490	0.0484	0.0563	0.0742	0.0923	0.0649	0.0602	0.0541	0.0423	0.0578
S	0.5600	0.4645	0.4689	0.3613	0.1779	1.0000	0.1883	0.4384	0.1983	0.3227
Cl	0.0210	0.0210	0.0158	0.0206	0.0017	0.0180	0.0090	0.0131	0.0096	0.0086
Ca	0.0893	0.0829	0.0692	0.1126	0.1124	0.1326	0.1205	0.1203	0.0799	0.0664
Ti	0.0000	0.0054	0.0000	0.0000	0.0000	0.0069	0.0075	0.0037	0.0077	0.0000
Fe	0.4104	0.3100	0.0651	0.3709	0.1309	0.4751	0.2169	0.8853	0.3090	0.2063
Zn	0.0543	0.0673	0.0464	0.0000	0.0000	0.0304	0.0407	0.0774	0.0645	0.0945
Sn	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ba	0.0102	0.0000	0.0000	0.0000	0.0000	0.0000	0.0090	0.0065	0.0000	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pb	0.3448	0.2422	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1617
Mn	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Br	0.0785	0.0651	0.0446	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Cd	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
K	0.0065	0.0059	0.0065	0.0137	0.0168	0.0097	0.0075	0.0084	0.0048	0.0031
Cu	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V	0.0000	0.0140	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Sb	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total Percent of Particulate	1.6714	1.3945	0.7927	1.0096	0.5337	1.8122	0.7077	1.6754	0.7758	0.9454
Total Vehicle Particulate, g/test[a]	2.59	2.64	3.69	1.88	1.68	1.82	1.58	1.92	1.67	2.23

[a] based on data from 47 mm Pallflex filter data

PERCENT TRACE ELEMENTS IN PARTICULATE MATTER (CONT'D)

Fuel	EM-460-F		EM-461-F		EM-395-F			EM-463-F	
Cycle	FTP_c	FTP_h	FTP_c	FTP_h	FTP_c	FTP_h	85 km/hr	FTP_c	FTP_h
Elements, pct									
Na	0.0053	0.0000	0.0000	0.0000	0.0059	0.0066	0.0094	0.0157	0.0296
Mg	0.0190	0.0135	0.0185	0.0168	0.0252	0.0142	0.0152	0.0141	0.0124
Al	0.0295	0.0135	0.0185	0.0089	0.0185	0.0028	0.0023	0.0039	0.0054
Si	0.0380	0.0217	0.0371	0.0287	0.0353	0.0245	0.0141	0.0219	0.0232
P	0.0348	0.0314	0.2116	0.2478	0.2271	0.2283	0.1870	0.1648	0.1546
S	0.2700	0.1704	0.3205	0.1804	0.2902	0.1679	0.2673	0.3161	0.2606
Cl	0.0105	0.0090	0.0131	0.0099	0.0151	0.0104	0.0082	0.0112	0.0075
Ca	0.1102	0.0635	0.4340	0.4668	0.4483	0.4292	0.2931	0.3487	0.3107
Ti	0.0058	0.0037	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Fe	0.4051	0.2309	0.4571	0.1764	0.3936	0.1425	0.1002	0.2222	0.1131
Zn	0.0659	0.0575	0.0803	0.0852	0.0942	0.0698	0.1166	0.0636	0.0576
Sn	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ba	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pb	0.2062	0.1764	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Mn	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Br	0.0000	0.0583	0.0000	0.0337	0.0202	0.0179	0.0399	0.0394	0.0000
Cd	0.0000	0.0000	0.0039	0.0030	0.0017	0.0019	0.0018	0.0028	0.0027
K	0.0063	0.0037	0.0116	0.0000	0.0101	0.0028	0.0029	0.0073	0.0054
Cu	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ni	0.0000	0.0000	0.0409	0.0000	0.0378	0.0160	0.0000	0.0382	0.0000
V	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Sb	0.0000	0.0000	0.0463	0.0575	0.0513	0.0557	0.0346	0.0354	0.0355
Total Percent of Particulate	1.2066	0.8535	1.6934	1.3151	1.6753	1.1905	1.0926	1.3053	1.0183
Total Vehicle Particulate, g/test[a]	2.58	2.54	2.03	1.80	2.11	2.07	2.74	3.38	3.38

[a] based on data from 47 mm Pallflex filter data

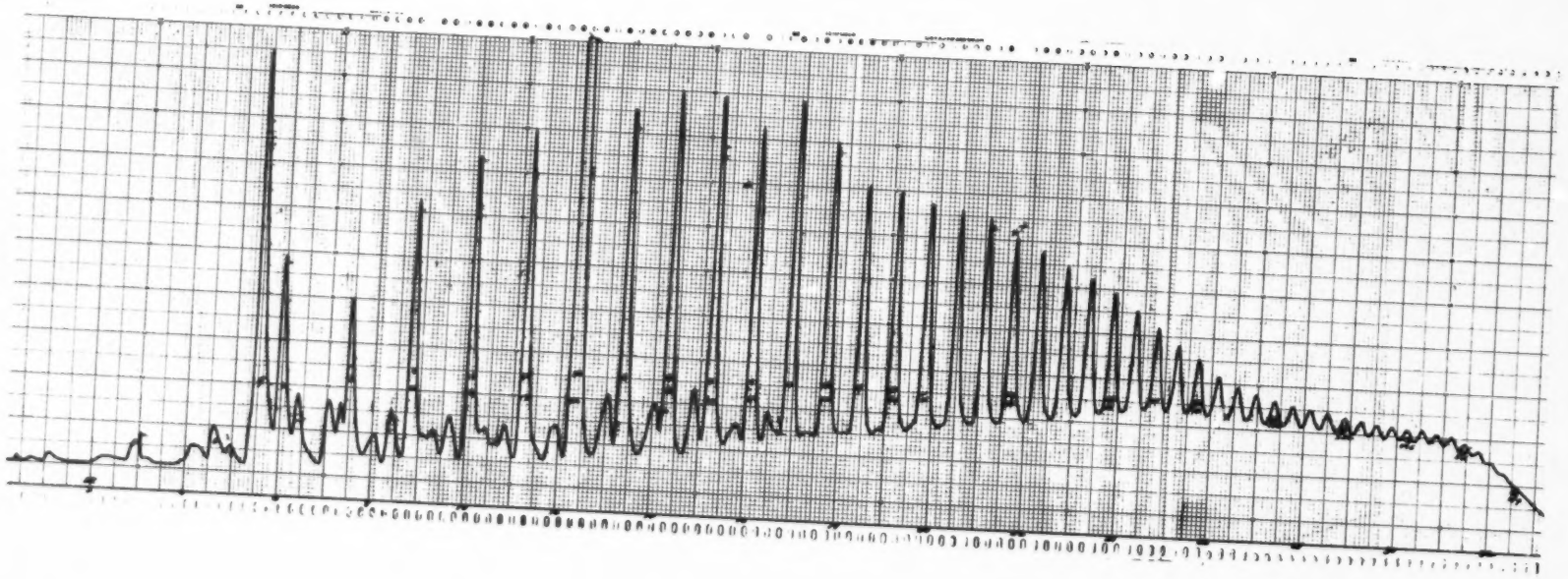


Figure E-1. "Altamont" crude oil output from high-temperature gas chromatograph run.

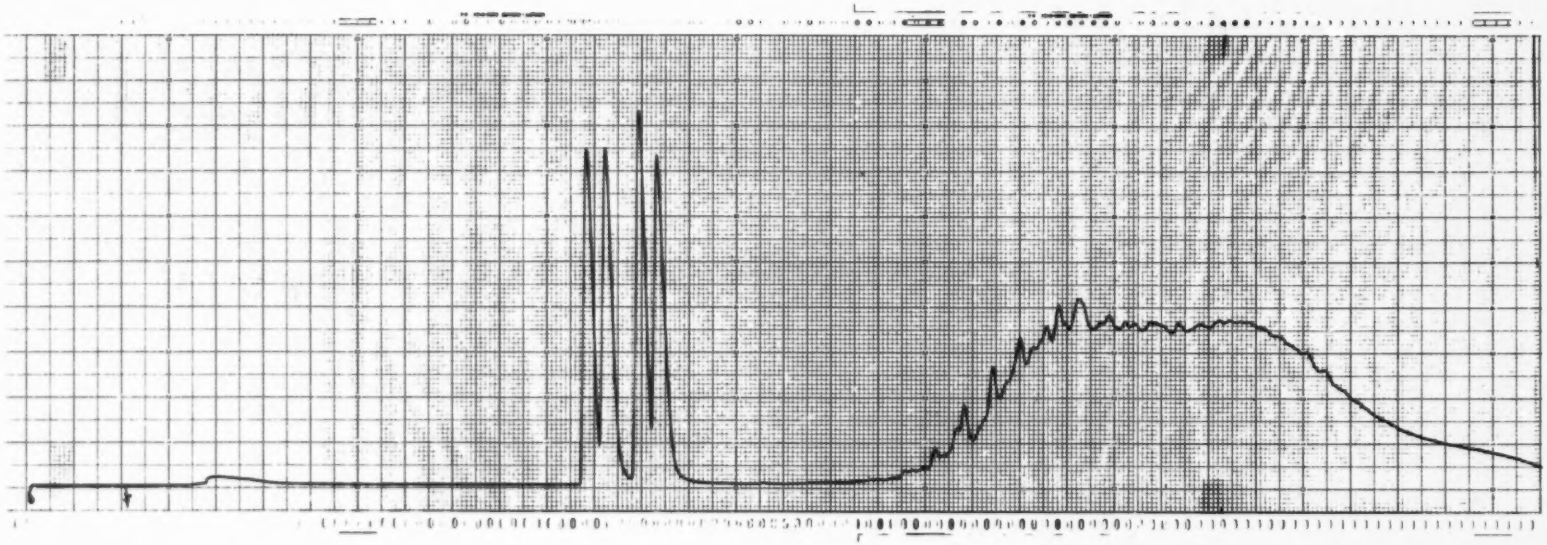


Figure E-2. Example of a chromatograph of organic solubles from particulate matter, vehicle operated on EM-463-F fuel.

SOUTHWEST RESEARCH INSTITUTE

POST OFFICE DRAWER 28510 · 6220 CULEBRA ROAD · SAN ANTONIO, TEXAS 78284 · (512) 684-5111

Ms. Debra Sklarew
Battelle Avenue
PO Box 9999
Richland WA 99352

Dear Debra:

The enclosed filters have been sent to you at the request of Tom Baines of the Emission Control Technology Division, EPA, Ann Arbor, Michigan. These samples are to be used for nitroaromatic analysis via HERL-EMSL contract. The particulate was collected on 20 x 20 inch Pallflex filters from a 1975 Mercedes 240D vehicle. The 147 CID diesel engine was fueled with various fuels whose specifications are summarized in Table 1.

The vehicle was driven through five consecutive Highway Fuel Economy Tests (HFET's). The vehicle's exhaust was drawn through a dilution tunnel and a portion of the diluted exhaust was drawn through the filter. The particulate weights of each filter are listed in Table 2.

If you have any questions regarding the filters, please call me at (512) 684-5111, ext. 2937.

Sincerely,

- Bruce Bykowski -

Bruce B. Bykowski
Research Scientist
Department of Emissions Research

BBB:cp
Enclosures
cc: T. M. Baines, EPA-AA
C. T. Hare, SwRI

TABLE 1. FUEL PROPERTIES

Substance	Base Fuel, Heavy Aromatics, DII-3	Minimum Quality No. 2	Shale Diesel Fuel-Marine	Base Fuel + Isoquinoline
Code (EM-)	463-F	241-F	453-F	405-F
Cetane No.	60	--	48.6	61
Cetane Index (D976)	44	41.8	54.5	56
50% point, °F	421	258	--	418
Gravity, °API @ 60°F	40.0	32.8	37.9	46.4
Density, g/mℓ @ 60°F	0.826	0.861	0.835	0.795
Carbon, wt. %	86.38	87.5	86.3	--
Hydrogen, wt. %	13.08	12.3	13.4	85.09
Oxygen, wt. %	0.21	--	--	14.58
Nitrogen, ppm (oxid. pyrolysis)	718	240	5	--
Calculated H/C, numeric	1.80	1.68	--	930
Carbon No. Range (G.C.)	10-16	--	--	2.05
Aromatics, vol. %	30.8	34.6	29.9	10-14
Olefins, vol. % (D1319)	1.2	1.0	1.6	6.6
Paraffins, vol. %	68.0	64.4	--	1.5
Viscosity, cs @ 100°F (D445)	1.51	2.44	2.61	91.8
Gum, mg/100 mℓ (D481)	2.4	11.8	0.3	1.58
Boiling Range, °C (IBP-EP, D86)				0.6
5%	202	--	229	208
20%	209	227	246	211
50%	216	258	--	214
70%	222	277	--	218
95%	244	311	302	229
Residue, wt. % (D86)	1.0	0.5	--	0.5
Boiling Range, °C (IBP-EP, D2887)				
5%	199	--	196	195
20%	215	--	237	204
50%	228	--	--	219
70%	240	--	--	231
95%	269	--	325	251
Residue, wt. % (D2887)	0	--	--	0.5

TABLE 2. FILTER CODES AND WEIGHTS

Fuel Code	Filter Code	Filter Weight, g
EM-463-F	5423-P20-42	0.6319
	5423-P20-43	0.5895
	5423-P20-44	0.5736
	5423-P20-45	0.5693
	5423-P20-46	0.5715
EM-453-F	5423-P20-47	0.4271
	5423-P20-48	0.4321
	5423-P20-49	0.4538
	5423-P20-50	0.4515
	5423-P20-51	0.4728
EM-241-F	5423-P20-52	0.6502
	5423-P20-53	0.6496
	5423-P20-54	0.6873
	5423-P20-55	0.6795
	5423-P20-56	0.6688
EM-405-F	5423-P20-57	0.3793
	5423-P20-58	0.3914
	5423-P20-59	0.3961
	5423-P20-60	0.4001

HFET VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 463-B RUN 1
VEHICLE MODEL 75 MERCEDES 240D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 8/20/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-463-F
ODOMETER 14532. KM(9030. MILES)

BAROMETER 741.17 MM HG(29.18 IN HG)
RELATIVE HUMIDITY 52. PCT
DRY BULB TEMP. 27.8 DEG C(82.0 DEG F)
ABS. HUMIDITY 12.4 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.06

0 BAG RESULTS

TEST CYCLE	HFET
BLOWER DIF P MM. H2O(IN. H2O)	604.5 (23.8)
BLOWER INLET P MM. H2O(IN. H2O)	477.5 (18.8)
BLOWER INLET TEMP. DEG. C(DEG. F)	42.2 (108.0)
BLOWER REVOLUTIONS	19372.
TOT FLOW STD. CU. METRES(SCF)	187.0 (6602.)
HC SAMPLE METER/RANGE/PPM	12.2/11/ 12.
HC BCKGRD METER/RANGE/PPM	3.7/ 1/ 3.
CO SAMPLE METER/RANGE/PPM	11.3/13/ 10.
CO BCKGRD METER/RANGE/PPM	1.3/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	17.9/ 3/ .29
CO2 BCKGRD METER/RANGE/PCT	3.0/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	13.4/ 2/ 13.
NOX BCKGRD METER/RANGE/PPM	1.4/ 2/ 1.
DILUTION FACTOR	46.47
HC CONCENTRATION PPM	9.
CO CONCENTRATION PPM	9.
CO2 CONCENTRATION PCT	.24
NOX CONCENTRATION PPM	12.0
HC MASS GRAMS	.97
CO MASS GRAMS	1.87
CO2 MASS GRAMS	825.8
NOX MASS GRAMS	4.54
RUN TIME SECONDS	765.
DFC, WET (DRY)	.978 (.962)
SCF, WET (DRY)	1.000 (.981)
VOL (SCM)	187.0
SAM BLR (SCM)	43.51
KM (MEASURED)	16.10

TEST NUMBER.		463-B
BAROMETER.	MM HG	741.2
HUMIDITY.	G/KG	12.4
TEMPERATURE.	DEG C	27.8
CARBON DIOXIDE.	G/KM	51.3
FUEL CONSUMPTION.	L/100KM	1.98
HYDROCARBONS.	G/KM	.06
CARBON MONOXIDE.	G/KM	.12
OXIDES OF NITROGEN.	G/KM	.28

HFET VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 453-T RUN 1
VEHICLE MODEL 75 MERCEDES 240-D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 9/23/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-453-F
ODOMETER 14660. KM(9109. MILES)

BAROMETER 739.90 MM HG(29.13 IN HG)
RELATIVE HUMIDITY 46. PCT

DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)
ABS. HUMIDITY 9.3 GM/KG

NOX HUMIDITY CORRECTION FACTOR .95

0 BAG RESULTS

TEST CYCLE	HFET
BLOWER DIF P MM. H2O(IN. H2O)	594.9 (23.5)
BLOWER INLET P MM. H2O(IN.H2O)	469.9 (18.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	40.6 (105.0)
BLOWER REVOLUTIONS	19391.
TOT FLOW STD. CU. METRES(SCF)	189.5 (6691.)
HC SAMPLE METER/RANGE/PPM	18.1/11/ 18.
HC BCKGRD METER/RANGE/PPM	8.7/ 1/ 8.
CO SAMPLE METER/RANGE/PPM	33.5/13/ 31.
CO BCKGRD METER/RANGE/PPM	3.1/13/ 3.
CO2 SAMPLE METER/RANGE/PCT	53.4/ 3/ .93
CO2 BCKGRD METER/RANGE/PCT	3.7/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	40.9/ 2/ 41.
NOX BCKGRD METER/RANGE/PPM	1.7/ 2/ 2.
DILUTION FACTOR	14.29
HC CONCENTRATION PPM	10.
CO CONCENTRATION PPM	27.
CO2 CONCENTRATION PCT	.88
NOX CONCENTRATION PPM	39.3
HC MASS GRAMS	1.13
CO MASS GRAMS	5.97
CO2 MASS GRAMS	3053.9
NOX MASS GRAMS	13.60
RUN TIME SECONDS	766.
DEC. WET (DRY)	.930 (.914)
SCF. WET (DRY)	1.000 (.977)
VOL (SCM)	189.5
SAM PLR (SCM)	43.70
KM (MEASURED)	16.21
TEST NUMBER.	453-T
BAROMETER. MM HG	739.9
HUMIDITY. G/KG	9.3
TEMPERATURE. DEG C	25.0
CARBON DIOXIDE. G/KM	188.4
FUEL CONSUMPTION. L/100KM	7.17
HYDROCARBONS. G/KM	.07
CARBON MONOXIDE. G/KM	.37
OXIDES OF NITROGEN. G/KM	.84

HFET VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 241-T RUN 1
VEHICLE MODEL 75 MERCEDES 240-D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 9/24/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-241-F
ODOMETER 14754. KM(9168. MILES)

BAROMETER 737.62 MM HG(29.04 IN HG)
RELATIVE HUMIDITY 44. PCT
DRY BULB TEMP. 24.1 DEG C(79.0 DEG F)
ABS. HUMIDITY 9.5 GM/KG

NOX HUMIDITY CORRECTION FACTOR .96

0 BAG RESULTS

		HFET
TEST CYCLE		
BLOWER DIF P MM. H20(IN. H20)		629.9 (24.8)
BLOWER INLET P MM. H20(IN. H20)		477.5 (18.8)
BLOWER INLET TEMP. DEG. C(DEG. F)		40.6 (105.0)
BLOWER REVOLUTIONS		19392.
TOT FLOW STD. CU. METRES(SCF)		187.8 (6631.)
HC SAMPLE METER/RANGE/PPM		19.7/11/ 20.
HC BCKGRD METER/RANGE/PPM		7.5/ 1/ 8.
CO SAMPLE METER/RANGE/PPM		41.4/13/ 38.
CO BCKGRD METER/RANGE/PPM		7.0/13/ 4.
CO2 SAMPLE METER/RANGE/PCT		55.4/ 3/ .97
CO2 BCKGRD METER/RANGE/PCT		3.5/ 3/ .05
NOX SAMPLE METER/RANGE/PPM		45.5/ 2/ 46.
NOX BCKGRD METER/RANGE/PPM		1.4/ 2/ 1.
DILUTION FACTOR		13.70
HC CONCENTRATION PPM		13.
CO CONCENTRATION PPM		31.
CO2 CONCENTRATION PCT		.92
NOX CONCENTRATION PPM		44.2
HC MASS GRAMS		1.38
CO MASS GRAMS		4.88
CO2 MASS GRAMS		3171.3
NOX MASS GRAMS		15.27
RUN TIME	SECONDS	766.
DEC. WET (DRY)		.927 (.914)
SCF, WET (DRY)		1.000 (.977)
VOL (SCM)		187.8
SAM BLR (SCM)		42.83
KM (MEASURED)		16.16
TEST NUMBER.		241-T
BAROMETER.	MM HG	737.6
HUMIDITY.	G/KG	9.5
TEMPERATURE.	DEG C	24.1
CARBON DIOXIDE.	G/KM	194.3
FUEL CONSUMPTION.	L/100KM	7.15
HYDROCARBONS.	G/KM	.09
CARBON MONOXIDE.	G/KM	.43
OXIDES OF NITROGEN.	G/KM	.95

HFET VEHICLE EMISSIONS RESULTS
PROJECT 11-5423-001

TEST NO. 405-T RUN 1
VEHICLE MODEL 75 MERCEDES 240-D
ENGINE 2.4 L(147. CID) L-4
TRANSMISSION M4

VEHICLE NO.1
DATE 9/25/80
BAG CART NO. 1
DYNO NO. 2
CVS NO. 3

TEST WEIGHT 1588. KG(3500. LBS)
ACTUAL ROAD LOAD 8.4 KW(11.2 HP)
DIESEL EM-405-F
ODOMETER 14864. KM(9236. MILES)

BAROMETER 737.42 MM HG(29.04 IN HG)
RELATIVE HUMIDITY 50. PCT
DRY BULB TEMP. 24.1 DEG C(79.0 DEG F)
ABS. HUMIDITY 11.0 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.01

0 BAG RESULTS

TEST CYCLE		HFET
BLOWER DIF P MM. H2O(IN. H2O)		609.6 (24.0)
BLOWER INLET P MM. H2O(IN. H2O)		482.6 (19.0)
BLOWER INLET TEMP. DEG. C(DEG. F)		38.9 (102.0)
BLOWER REVOLUTIONS		19400.
TOT FLOW STD. CU. METRES(SCF)		189.1 (6678.)
HC SAMPLE METER/RANGE/PPM		11.5/11/ 12.
HC BCKGRD METER/RANGE/PPM		4.1/ 1/ 4.
CO SAMPLE METER/RANGE/PPM		27.1/13/ 24.
CO BCKGRD METER/RANGE/PPM		.5/13/ 0.
CO2 SAMPLE METER/RANGE/PCT		51.9/ 3/ .90
CO2 BCKGRD METER/RANGE/PCT		2.9/ 3/ .04
NOX SAMPLE METER/RANGE/PPM		37.9/ 2/ 38.
NOX BCKGRD METER/RANGE/PPM		.6/ 2/ 1.
DILUTION FACTOR		14.77
HC CONCENTRATION PPM		8.
CO CONCENTRATION PPM		23.
CO2 CONCENTRATION PCT		.84
NOX CONCENTRATION PPM		37.3
HC MASS GRAMS		.84
CO MASS GRAMS		5.10
CO2 MASS GRAMS		2984.3
NOX MASS GRAMS		13.61
RUN TIME	SECONDS	766.
DEC. WET (DRY)		.932 (.917)
SCF, WET (DRY)		1.000 (.975)
VOL (SCM)		189.1
SAM BLR (SCM)		43.67
KM (MEASURED)		16.13
TEST NUMBER.		405-T
BAROMETER.	MM HG	737.6
HUMIDITY.	G/KG	11.0
TEMPERATURE.	DEG C	24.1
CARBON DIOXIDE.	G/KM	185.2
FUEL CONSUMPTION.	L/100KM	7.50
HYDROCARBONS.	G/KM	.05
CARBON MONOXIDE.	G/KM	.32
OXIDES OF NITROGEN.	G/KM	.84

APPENDIX F

STATISTICAL DATA

COMPUTER DATA FILE OF ALL VARIABLES

81/03/09. 15.11.30.
PROGRAM DATALN

1-5 FUEL CODE	6-13 VAR 1 CETANE NO.	14-21 VAR 2 CETANE INDEX	22-29 VAR 3 GRAVITY API	30-37 VAR 4 DENSITY G/ML	38-45 VAR 5 C WT. %	46-53 VAR 6 H WT. %	54-61 VAR 7 O WT. %	62-69 VAR 8 N PPM	70-77 VAR 9 H/C
39501	61.5	57.8	47.0	0.793	85.1	14.7	-0	0	2.05
40101	54.5	56.2	45.3	0.800	85.9	13.8	-0	0	1.92
40401	61.5	56.8	46.7	0.794	85.1	14.6	-0	479	2.04
40501	61.2	56.2	46.4	0.795	85.1	14.6	-0	930	2.05
43001	62.6	55.8	46.2	0.796	86.0	13.8	-0	493	1.91
43401	44.1	44.1	40.1	0.825	86.7	13.1	-0	5	1.80
43801	64.2	57.5	47.0	0.793	84.6	13.2	-0	0	1.95
44801	55.8	60.5	49.3	0.783	85.1	14.6	-0	0	2.04
46001	46.0	47.5	42.1	0.815	86.4	13.4	-0	0	1.84
46101	67.8	61.5	47.5	0.791	85.2	14.5	-0	0	2.02
46301	60.0	43.9	40.0	0.826	86.4	13.1	0.21	718	1.80

1-5 FUEL CODE	6-13 VAR 10 ARO. VOL. %	14-21 VAR 11 OLEFINS VOL. %	22-29 VAR 12 PARA. VOL. %	30-37 VAR 13 VISC. CS	38-45 VAR 14 GUM, MG /100 ML	46-53 VAR 15 IBP DEG. C	54-61 VAR 16 10% PT. DEG. C	62-69 VAR 17 20% PT. DEG. C	70-77 VAR 18 30% PT. DEG. C
39502	5.8	1.5	92.7	1.59	0.2	203.	211.	212.	213.
40102	2.7	1.9	95.4	1.69	0.5	193.	206.	210.	213.
40402	6.1	1.5	92.4	1.59	0.3	194.	211.	212.	213.
40502	6.6	1.5	91.8	1.58	0.6	194.	210.	211.	212.
43002	8.8	1.8	89.4	1.59	14.3	200.	210.	211.	212.
43402	31.5	2.9	65.6	1.51	2.4	191.	206.	209.	211.
43802	6.8	6.6	86.6	1.55	1.1	203.	210.	211.	212.
44802	4.9	1.8	93.3	1.40	0.8	175.	189.	195.	201.
46002	32.1	1.0	66.9	1.47	1.4	203.	209.	211.	212.
46102	5.1	1.0	93.9	1.74	1.4	207.	216.	218.	219.
46302	30.8	1.2	68.0	1.51	2.4	190.	206.	209.	211.

1-5 FUEL CODE	6-13 VAR 19 40% PT. DEG. C	14-21 VAR 20 50% PT. DEG. C	22-29 VAR 21 60% PT. DEG. C	30-37 VAR 22 70% PT. DEG. C	38-45 VAR 23 80% PT. DEG. C	46-53 VAR 24 90% PT. DEG. C	54-61 VAR 25 EP DEG. C	62-69 VAR 26 RESIDUE WT. %	70-77 VAR 27 IBP DEG. C
39503	214.	216.	217.	218.	221.	224.	252.	0.8	140.
40103	217.	221.	224.	228.	233.	239.	261.	1.0	138.
40403	214.	215.	217.	218.	221.	224.	253.	0.8	146.
40503	213.	214.	216.	218.	220.	224.	255.	0.5	154.
43003	213.	214.	217.	219.	222.	228.	249.	1.5	145.
43403	213.	216.	218.	222.	226.	234.	266.	1.0	194.
43803	213.	214.	217.	219.	221.	224.	252.	1.0	184.
44803	206.	209.	213.	216.	219.	223.	249.	1.0	147.
46003	213.	214.	216.	218.	221.	224.	255.	0.5	179.
46103	221.	223.	227.	231.	238.	251.	286.	1.0	183.
46303	213.	216.	218.	222.	226.	234.	266.	0.3	192.

1-5 FUEL CODE	6-13 VAR 28 10% PT. DEG. C	14-21 VAR 29 20% PT. DEG. C	22-29 VAR 30 30% PT. DEG. C	30-37 VAR 31 40% PT. DEG. C	38-45 VAR 32 50% PT. DEG. C	46-53 VAR 33 60% PT. DEG. C	54-61 VAR 34 70% PT. DEG. C	62-69 VAR 35 80% PT. DEG. C	70-77 VAR 36 90% PT. DEG. C
39504	197.	202.	208.	213.	217.	222.	229.	234.	239.
40104	184.	190.	207.	215.	223.	231.	239.	247.	255.
40404	197.	203.	209.	214.	218.	223.	230.	235.	240.
40504	198.	204.	210.	215.	219.	225.	231.	237.	243.
43004	200.	208.	213.	217.	220.	224.	231.	236.	240.
43404	207.	215.	220.	225.	228.	235.	240.	244.	258.
43804	203.	210.	216.	222.	226.	230.	237.	242.	247.
44804	164.	181.	203.	211.	218.	224.	230.	237.	244.
46004	198.	206.	210.	216.	219.	226.	231.	235.	239.
46104	202.	211.	216.	219.	225.	233.	238.	255.	272.
46304	207.	215.	220.	225.	228.	235.	240.	244.	258.

1-5 FUEL CODE	6-13 VAR 37 EP DEG. C	14-21 VAR 38 RESIDUE WT. %
39505	269.	0
40105	278.	0
40405	279.	0
40505	294.	0.5
43005	265.	0
43405	283.	0
43805	270.	0
44805	265.	0
46005	264.	0
46105	303.	0
46305	283.	0

1-5 FUEL CODE	6-13 VAR 101 HC G/KM	14-21 VAR 102 CO G/KM	22-29 VAR 103 NOX G/KM	30-37 VAR 104 CO2 G/KM	38-45 VAR 105 FUEL L/100KM	46-53 VAR 106 FORMAL. MG/KM	54-61 VAR 107 ACETAL. MG/KM	62-69 VAR 108 ACETONE MG/KM	70-77 VAR 109 ISOBUT. MG/KM
39506	0.09	0.53	0.79	236.	9.51	0.26	0.05	0.00	5.32
40406	0.08	0.47	0.76	234.	9.50	0.03	0.00	0.00	16.3
40506	0.08	0.46	0.89	237.	9.59	9.66	4.96	0.00	6.42
43006	0.09	0.52	0.84	244.	9.76	0.00	0.00	0.00	13.3
43406	0.12	0.59	0.88	248.	9.52	2.80	0.00	0.00	0.00
43806	0.09	0.48	0.85	241.	9.84	0.00	0.00	0.00	0.00
44806	0.11	0.48	0.82	231.	9.51	4.87	3.31	0.00	0.51
40106	0.11	0.50	0.85	239.	9.55	4.09	0.80	0.00	0.00
46006	0.13	0.60	0.92	245.	9.56	0.00	0.00	0.00	0.00
46106	0.08	0.47	0.86	237.	9.63	6.79	0.00	2.04	0.00
46306	0.13	0.66	1.04	250.	9.62	0.00	0.00	0.00	0.00

1-5	6-13	14-21	22-29	30-37	38-45	46-53	54-61
FUEL CODE	VAR 110 CROTON. MG/KM	VAR 111 HEXAN. MG/KM	VAR 112 BENZAL. MG/KM	VAR 113 TOT.ALD MG/KM	VAR 114 METHANE MG/KM	VAR 115 ETHANE MG/KM	VAR 116 ETHYL. MG/KM
39507	0.00	0.00	-0	0.31	7.09	18.3	0.95
40407	0.12	0.27	-0	0.30	5.06	14.9	0.34
40507	0.00	0.61	-0	15.2	8.56	18.4	0.35
43007	3.46	0.00	-0	0.00	-0	-0	-0
43407	0.00	0.00	-0	2.80	0.00	5.81	0.23
43907	0.00	0.00	-0	0.00	7.71	16.6	0.00
44807	0.10	0.00	-0	8.18	6.36	15.4	0.00
40107	0.00	0.00	-0	4.89	7.26	17.6	1.18
46007	0.00	0.00	-0	0.00	0.00	21.4	0.94
46107	0.00	0.00	-0	8.83	0.00	11.2	0.00
46307	0.00	0.00	-0	0.00	8.00	21.5	0.70

1-5	6-13	14-21	22-29	30-37	38-45	46-53	54-61	62-69	70-77
FUEL CODE	VAR 117 ACETYL. MG/KM	VAR 118 PROPANE MG/KM	VAR 119 PROPYL. MG/KM	VAR 120 BENZENE MG/KM	VAR 121 TOLUENE MG/KM	VAR 122 TOT.IHC MG/KM	VAR 123 LCA UG/L	VAR 124 LCO UG/L	VAR 125 TIA
39508	4.42	0.00	4.58	1.83	0.00	37.2	6.67	1.19	1.08
40408	3.27	0.00	3.84	3.42	0.00	30.8	9.25	1.46	1.16
40508	3.19	0.00	4.10	2.74	1.23	38.5	5.64	0.553	0.93
43008	-0	-0	-0	-0	-0	-0	2.71	0.017	0.70
43408	1.50	0.34	0.32	0.00	0.00	8.2	7.14	2.42	1.38
43808	4.62	0.00	4.31	0.30	0.00	33.5	6.92	3.62	1.56
44008	3.71	0.00	4.93	1.05	0.00	31.4	1.99	2.53	1.40
40108	4.24	0.00	4.97	2.11	0.00	37.4	4.42	1.70	1.23
46008	5.31	0.00	5.87	4.85	0.00	38.4	10.44	3.66	1.56
46108	0.00	0.00	5.64	0.00	0.00	25.6	4.65	2.15	1.33
46308	3.51	0.00	6.75	0.00	4.01	44.5	4.65	2.15	1.33

1-5	6-13	14-21	22-29	30-37	38-45	46-53	54-61	62-69	70-77
FUEL CODE	VAR 126 PHEN.,F MG/KM	VAR 127 SALI.,F MG/KM	VAR 128 CRES.,F MG/KM	VAR 129 GRP.5,F MG/KM	VAR 130 TRI.,F MG/KM	VAR 131 TET.,F MG/KM	VAR 132 PRO.,F MG/KM	VAR 133 TOTAL,F MG/KM	VAR 134 PHEN.,U MG/KM
39509	0.10	0.18	0.07	0.13	0.00	0.90	0.32	1.69	0.08
40409	0.61	2.39	0.23	0.00	0.00	0.31	0.79	4.33	0.00
40509	2.54	11.3	0.90	0.00	1.64	9.64	3.37	29.4	0.00
43009	0.00	122.	0.00	0.00	0.00	0.00	6.43	128.	0.08
43409	0.00	0.55	0.00	0.00	0.05	0.06	0.00	0.66	0.00
43809	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.17	0.00
44009	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.21	0.00
40109	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
46009	0.00	0.11	0.00	0.05	0.00	1.14	0.00	1.30	0.00
46109	0.00	0.00	0.00	0.14	0.00	0.41	0.00	0.55	0.00
46309	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.18	0.00

1-5 FUEL CODE	6-13 VAR 135 SALI.,U MG/KM	14-21 VAR 136 CRES.,U MG/KM	22-29 VAR 137 GRP.5,U MG/KM	30-37 VAR 138 TRI.,U MG/KM	38-45 VAR 139 TET.,U MG/KM	46-53 VAR 140 PRO.,U MG/KM	54-61 VAR 141 TOTAL,U MG/KM
39510	0.00	0.00	0.06	0.00	0.00	0.10	0.24
40410	0.51	0.00	0.27	0.00	0.08	0.85	1.71
40510	0.44	0.00	0.00	0.00	3.96	0.09	4.49
43010	0.34	0.00	0.00	0.00	0.00	5.24	5.66
43410	0.00	0.00	0.09	0.00	0.13	0.00	0.22
43810	0.00	0.00	0.00	0.00	0.00	0.00	0.00
44810	0.00	0.00	0.00	0.00	2.99	0.00	2.99
40110	0.00	0.00	0.00	0.00	0.49	0.00	0.49
46010	0.00	0.00	0.00	0.00	0.44	0.00	0.44
46110	0.25	0.00	0.14	0.00	3.52	0.00	3.92
46310	0.00	0.00	0.00	0.00	0.00	0.00	0.00

1-5 FUEL CODE	6-13 VAR 201 PART. MG/KM	14-21 VAR 202 SOLUBLE PCT	22-29 VAR 203 C MG/KM	30-37 VAR 204 H MG/KM	38-45 VAR 205 N MG/KM	46-53 VAR 206 BAP UG/KM	54-61 VAR 207 NA PCT	62-69 VAR 208 MG PCT	70-77 VAR 209 AL PCT
39511	171.	15.8	150.	7.28	0.46	0.59	0.0093	0.020	0.010
40411	162.	13.4	141.	8.65	0.16	0.25	0.0067	0.024	0.016
40511	162.	10.5	139.	8.38	0.16	0.35	0.013	0.024	0.013
43011	180.	12.7	144.	4.60	0.33	0.96	0	0.029	0.046
43411	212.	13.0	171.	5.21	0.88	0.37	0	0.014	0.014
43811	155.	18.3	122.	9.46	0.93	0.21	0	0.0071	0.0069
44811	142.	18.8	121.	4.61	0.74	0.51	0	0.012	0.016
40111	151.	15.7	119.	3.93	0.58	0.42	0	0.018	0.016
46011	219.	13.8	186.	4.60	0.66	0.73	0.0023	0.016	0.020
46111	159.	16.5	126.	3.82	0.57	0.43	0	0.018	0.013
46311	287.	12.1	238.	4.31	0.89	0.43	0.024	0.013	0.0048

1-5 FUEL CODE	6-13 VAR 210 SI PCT	14-21 VAR 211 P PCT	22-29 VAR 212 S PCT	30-37 VAR 213 CL PCT	38-45 VAR 214 CA PCT	46-53 VAR 215 TI PCT
39512	0.028	0.14	0.24	0.013	0.27	0.0008
40412	0.040	0.066	0.30	0.0044	0.11	0.0029
40512	0.031	0.061	0.32	0.035	0.098	0.0014
43012	0.081	0.075	0.55	0.0083	0.16	0.016
43412	0.032	0.049	0.51	0.021	0.086	0.0031
43812	0.011	0.085	0.27	0.0098	0.11	0
44812	0.033	0.062	0.54	0.013	0.13	0.0072
40112	0.029	0.047	0.27	0.011	0.097	0.0060
46012	0.029	0.033	0.21	0.0096	0.084	0.0046
46112	0.032	0.23	0.24	0.011	0.45	0
46312	0.023	0.16	0.28	0.0091	0.33	0

1-5 FUEL CODE	6-13 VAR 216 ZN PCT	14-21 VAR 217 SN PCT	22-29 VAR 218 BA PCT	30-37 VAR 219 FE PCT	38-45 VAR 220 PB PCT	46-53 VAR 221 BR PCT	54-61 VAR 222 CD PCT	62-69 VAR 223 K PCT	70-77 VAR 224 NI PCT
39513	0.076	0.0015	0.0002	0.39	0	0.0094	0.0009	0.0011	0.013
40413	0.082	0.0030	0.0020	0.52	0	0	0	0.0013	0
40513	0.095	0.0039	0	1.17	0	0	0	0.0010	0
43013	0.091	0	0	0.99	0	0	0	0.0060	0
43413	0.062	0	0.0044	0.35	0.29	0.071	0	0.0062	0
43813	0	0	0	0.23	0	0	0	0.016	0
44813	0.036	0	0.0051	0.33	0	0	0	0.0084	0
40113	0.070	0	0.0028	0.56	0	0	0	0.0063	0
46013	0.061	0	0	0.31	0.19	0.033	0	0.0048	0
46113	0.083	0	0	0.30	0	0.019	0.0034	0.0050	0.018
46313	0.060	0	0	0.16	0	0.017	0.0027	0.0062	0.016

1-5 FUEL CODE	6-13 VAR 225 V PCT	14-21 VAR 226 SB PCT	22-29 VAR 227 TOT ELE PCT
39514	0	0.027	1.25
40414	0	0	0.70
40514	0	0	1.87
43014	0	0	2.06
43414	0.0080	0	1.51
43814	0	0	0.74
44814	0	0	1.18
40114	0	0	1.16
46014	0	0	1.01
46114	0	0.053	1.48
46314	0	0.036	1.14

1-5 FUEL CODE	6-13 VAR 228 CS PEAK %	14-21 VAR 229 CI AVG %	22-29 VAR 230 1ST ACC PEAK %	30-37 VAR 231 IDLE125 AVG %	38-45 VAR 232 ACC.164 PEAK %	46-53 VAR 233 SOL. C PCT	54-61 VAR 234 SOL. H PCT	62-69 VAR 235 SOL. N PCT	70-77 VAR 236 SOL. S PCT
39515	21.7	6.0	26.1	2.1	5.0	77.9	10.7	0.56	0.81
40415	31.5	8.0	20.8	1.0	5.1	76.2	10.3	0.88	0.32
40515	21.2	6.0	19.6	1.2	6.0	79.9	11.8	0.89	0.38
43015	-0	-0	-0	-0	-0	-0	-0	-0	-0
43415	42.8	6.3	14.4	2.0	9.1	71.7	8.5	1.39	0.96
43815	14.5	5.5	16.0	1.2	4.8	75.3	9.7	1.33	0.67
44815	26.7	5.6	28.9	0.7	5.0	75.1	10.0	1.35	0.60
40115	12.3	6.1	18.8	1.1	8.8	79.0	11.3	1.23	0.51
46015	22.4	6.8	46.7	2.4	12.7	82.4	12.1	0.22	0.39
46115	27.0	6.2	29.2	2.4	8.9	82.7	12.4	0.23	0.44
46315	17.6	7.4	23.8	2.6	21.0	82.3	12.3	0.24	0.50

1-5 FUEL CODE	6-13 VAR 237 SOL. O PCT	14-21 VAR 238 C PCT	22-29 VAR 239 H PCT	30-37 VAR 240 N PCT	38-45 VAR 241 100-CHNS PCT
39516	7.7	88.0	4.3	0.27	7.2
40416	8.2	87.1	5.3	0.10	7.2
40516	-0	86.0	5.2	0.10	8.4
43016	-0	80.0	2.6	0.19	16.7
43416	12.7	80.9	2.6	0.42	15.6
43816	12.8	78.9	6.1	0.60	14.1
44816	11.5	84.9	3.2	0.52	10.8
40116	6.4	78.8	2.6	0.38	18.0
46016	5.5	84.9	2.1	0.30	12.5
46116	4.8	79.1	2.4	0.36	17.9
46316	5.0	82.8	1.5	0.31	15.1

READY.

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES

1 81/02/23. 10.37.52.

FILE FUEL (CREATION DATE = 01/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10
V1	1.0000	.6656	.6189	-.6122	-.7063	.4605	99.0000	.3084	.6060	-.6737
V2	.6656	1.0000	.9806	-.9807	-.8484	.7636	99.0000	-.1806	.8894	-.9479
V3	.6189	.9806	1.0000	-.9993	-.8690	.7703	99.0000	-.1408	.9042	-.9232
V4	-.6122	-.9807	-.9993	1.0000	.8639	-.7707	99.0000	.1327	-.9037	.9281
V5	-.7063	-.8484	-.8690	.8639	1.0000	-.6355	99.0000	.0296	-.8773	.8146
V6	.4605	.7636	.7703	-.7707	-.6355	1.0000	99.0000	.1020	.9247	-.7205
V7	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V8	.3084	-.1806	-.1408	.1327	.0296	.1020	99.0000	1.0000	.0430	.0468
V9	.6060	.8894	.9042	-.9037	-.8773	.9247	99.0000	.0430	1.0000	-.8546
V10	-.6737	-.9479	-.9232	.9281	.8146	-.7205	99.0000	.0468	-.8546	1.0000
V11	.0958	.0782	.1083	-.1049	-.3504	-.4347	99.0000	-.2759	-.0782	-.1220
V12	.6659	.9448	.9158	-.9212	-.7738	.7833	99.0000	-.0120	.8709	-.9913
V13	.5211	.4083	.2364	-.2485	-.2068	.2635	99.0000	-.0081	.2705	-.4875
V14	.1279	-.0658	-.0449	.0356	.3155	-.2122	99.0000	.2416	-.2745	.0432
V15	.3184	.0957	-.0079	-.0054	-.1021	-.0811	99.0000	-.1423	.0002	-.0333
V16	.3725	.0042	-.1142	.0989	-.0523	-.0244	99.0000	.1585	.0115	-.0228
V17	.3420	-.0086	-.1482	.1342	.0026	-.0449	99.0000	.0984	-.0295	-.0061
V18	.3511	.0417	-.1175	.1052	.0034	-.0130	99.0000	.0323	-.0115	-.0544
V19	.3266	.1242	-.0622	.0529	.0201	.0286	99.0000	-.0956	.0054	-.1414

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

1 81/02/23. 18.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10
V20	.2156	.0630	-.1323	.1273	.1267	-.0208	99.0000	-.1818	-.0779	-.1080
V21	.2679	.1813	-.0130	.0107	.0620	.0042	99.0000	-.2411	-.0317	-.1967
V22	.1631	.0724	-.1159	.1174	.1768	-.1022	99.0000	-.2445	-.1543	-.0878
V23	.1495	.0738	-.1120	.1154	.1940	-.0713	99.0000	-.2673	-.1468	-.0713
V24	.1623	.0249	-.1524	.1594	.2383	-.0901	99.0000	-.2031	-.1835	-.0027
V25	.1200	-.0957	-.2576	.2696	.2143	-.0911	99.0000	-.1377	-.1809	.1721
V26	.1668	.4560	.4395	-.4437	-.1343	.0027	99.0000	-.3768	.1440	-.4615
V27	-.2227	-.5967	-.6339	.6499	.3765	-.6853	99.0000	-.0038	-.6260	.7093
V28	.1001	-.4954	-.5651	.5604	.2908	-.4678	99.0000	.2784	-.4355	.4613
V29	.0416	-.5537	-.6396	.6370	.3969	-.5824	99.0000	.2185	-.5587	.5209
V30	.0094	-.5832	-.6502	.6602	.4147	-.6759	99.0000	.1554	-.6316	.5727
V31	-.1249	-.6583	-.7137	.7246	.4671	-.8039	99.0000	.0779	-.7332	.6242
V32	-.0838	-.4887	-.5778	.5914	.3838	-.7331	99.0000	-.0757	-.6477	.4439
V33	-.1814	-.4984	-.6091	.6218	.4646	-.6585	99.0000	-.1217	-.6424	.4706
V34	-.1233	-.4180	-.5374	.5470	.4001	-.6515	99.0000	-.1464	-.6012	.3418
V35	.1793	.0375	-.1251	.1365	.1006	-.2142	99.0000	-.2490	-.1913	-.0182
V36	.1122	-.0899	-.2402	.2564	.2009	-.2186	99.0000	-.1826	-.2490	.1195
V37	.3156	.0610	-.0678	.0720	-.0721	.1969	99.0000	.3097	.1506	-.0779
V38	.1384	.0989	.1246	-.1386	-.2369	.3241	99.0000	.6547	.3397	-.1715

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

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81/02/23. 10.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
V1	.0958	.6659	.5211	.1279	.3184	.3725	.3420	.3511	.3266	.2156
V2	.0782	.9448	.4083	-.0658	.0957	.0042	-.0086	.0417	.1242	.0630
V3	.1003	.9158	.2364	-.0449	-.0079	-.1142	-.1482	-.1175	-.0622	-.1323
V4	-.1049	-.9212	-.2485	.0356	-.0054	.0989	.1342	.1052	.0529	.1273
V5	-.3504	-.7730	-.2068	.3155	-.1021	-.0523	.0026	.0034	.0201	.1267
V6	-.4347	.7833	.2635	-.2122	-.0811	-.0244	-.0449	-.0130	.0286	-.0208
V7	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V8	-.2759	-.0120	-.0081	.2416	-.1423	.1585	.0984	.0323	-.0956	-.1818
V9	-.0782	.8709	.2705	-.2745	.0002	.0115	-.0295	-.0115	.0054	-.0779
V10	-.1220	-.9913	-.4875	.0432	-.0333	-.0228	-.0061	-.0544	-.1414	-.1080
V11	1.0000	-.0099	-.1131	-.0424	.1183	-.0013	-.0472	-.0873	-.1489	-.1879
V12	-.0099	1.0000	.5063	-.0376	.0180	.0228	.0123	.0664	.1625	.1342
V13	-.1131	.5063	1.0000	.0335	.5911	.7083	.7654	.8361	.9147	.8798
V14	-.0424	-.0376	.0335	1.0000	.1432	.1068	.0678	.0244	-.0560	-.1272
V15	.1183	.0180	.5911	.1432	1.0000	.9054	.8921	.8566	.7216	.5337
V16	-.0013	.0228	.7083	.1068	.9054	1.0000	.9886	.9538	.8130	.6315
V17	-.0472	.0123	.7654	.0678	.8921	.9886	1.0000	.9871	.8869	.7353
V18	-.0873	.0664	.8361	.0244	.8566	.9538	.9871	1.0000	.9491	.8298
V19	-.1489	.1625	.9147	-.0560	.7216	.8130	.8869	.9491	1.0000	.9557

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
V20	-.1879	.1342	.8798	-.1272	.5337	.6315	.7353	.8298	.9557	1.0000
V21	-.1461	.2182	.8696	-.0814	.4573	.5219	.6359	.7491	.9160	.9714
V22	-.1442	.1082	.7635	-.0811	.3108	.3788	.5072	.6312	.8294	.9302
V23	-.2011	.0993	.7381	-.0799	.2849	.3478	.4796	.6075	.8122	.9187
V24	-.2280	.0336	.6782	-.0011	.2476	.3245	.4525	.5746	.7657	.8681
V25	-.2404	-.1411	.5477	-.1943	.2826	.3847	.4996	.5977	.7309	.7944
V26	.2877	.4278	.2600	.6042	.0766	-.0392	-.0411	-.0099	.0527	.0504
V27	.2766	-.7514	-.1741	-.1117	.1911	.1842	.2202	.2074	.1588	.1530
V28	.1528	-.4854	.2981	.1937	.6639	.7958	.7736	.7039	.5137	.3820
V29	.1646	-.5469	.3081	.2236	.6081	.7326	.7350	.6870	.5431	.4515
V30	.2726	-.6133	.1207	.2133	.3262	.4384	.4578	.4331	.3490	.3286
V31	.3756	-.6787	.0050	.1306	.1822	.2712	.3007	.2849	.2361	.2653
V32	.3903	-.4988	.1385	.0012	.0683	.1449	.2156	.2548	.3184	.4193
V33	.1939	-.4997	.1877	-.1175	.0250	.1101	.2105	.2776	.3943	.5297
V34	.2791	-.3811	.2820	-.1020	.0358	.1250	.2251	.2988	.4322	.5790
V35	.0664	.0099	.5745	-.1477	.1737	.2268	.3492	.4682	.6635	.7739
V36	-.0371	-.1151	.4692	-.1601	.0831	.1753	.2973	.4105	.5932	.7196
V37	-.2265	.1077	.5903	-.2845	.1661	.4354	.5007	.5642	.6343	.6380
V38	-.1173	.1860	.0506	-.1400	-.0640	.1148	.0657	.0217	-.0593	-.1458

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

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81/02/23. 18.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V21	V22	V23	V24	V25	V26	V27	V28	V29	V30
V1	.2679	.1631	.1495	.1623	.1200	.1668	-.2227	.1001	.0416	.0094
V2	.1813	.0724	.0738	.0249	-.0957	.4560	-.5967	-.4954	-.5537	-.5832
V3	-.0130	-.1159	-.1120	-.1524	-.2576	.4395	-.6339	-.5651	-.6396	-.6502
V4	.0107	.1174	.1154	.1594	.2696	-.4437	.6499	.5604	.6370	.6602
V5	.0620	.1768	.1940	.2383	.2143	-.1343	.3765	.2908	.3969	.4147
V6	.0042	-.1022	-.0713	-.0901	-.0911	.0827	-.6853	-.4678	-.5824	-.6759
V7	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V8	-.2411	-.2445	-.2673	-.2031	-.1377	-.3768	-.0838	.2784	.2185	.1554
V9	-.0317	-.1543	-.1468	-.1835	-.1809	.1440	-.6260	-.4355	-.5587	-.6316
V10	-.1967	-.0878	-.0713	-.0027	.1721	-.4615	.7093	.4613	.5209	.5727
V11	-.1461	-.1442	-.2011	-.2280	-.2404	.2877	.2766	.1528	.1646	.2726
V12	.2182	.1082	.0993	.0336	-.1411	.4278	-.7514	-.4854	-.5469	-.6133
V13	.8696	.7635	.7381	.6782	.5477	.2600	-.1741	.2981	.3081	.1207
V14	-.0814	-.0811	-.0799	-.0011	-.1943	.6042	-.1117	.1937	.2236	.2133
V15	.4573	.3108	.2849	.2476	.2826	.0766	.1911	.6639	.6081	.3262
V16	.5219	.3788	.3478	.3245	.3847	-.0392	.1842	.7958	.7326	.4384
V17	.6359	.5072	.4796	.4525	.4996	-.0411	.2202	.7736	.7350	.4578
V18	.7491	.6312	.6075	.5746	.5977	-.0099	.2074	.7039	.6870	.4331
V19	.9160	.8294	.8122	.7657	.7309	.0527	.1588	.5137	.5431	.3490

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

81/02/23. 18.37.52.

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FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V21	V22	V23	V24	V25	V26	V27	V28	V29	V30
V20	.9714	.9302	.9187	.8681	.7944	.0504	.1530	.3820	.4515	.3286
V21	1.0000	.9764	.9688	.9266	.8214	.1695	.1499	.2499	.3460	.2841
V22	.9764	1.0000	.9956	.9713	.8669	.1430	.2479	.2045	.3348	.3467
V23	.9688	.9956	1.0000	.9828	.8846	.1448	.2466	.1754	.3069	.3296
V24	.9266	.9713	.9828	1.0000	.9267	.1523	.3308	.2231	.3603	.4240
V25	.8214	.8669	.8846	.9267	1.0000	-.1117	.5494	.3668	.4749	.5412
V26	.1695	.1430	.1448	.1523	-.1117	1.0000	-.3187	-.1956	-.1523	-.0941
V27	.1499	.2479	.2466	.3308	.5494	-.3187	1.0000	.5950	.6847	.8365
V28	.2499	.2045	.1754	.2231	.3668	-.1956	.5950	1.0000	.9779	.8364
V29	.3460	.3348	.3069	.3603	.4749	-.1523	.6847	.9779	1.0000	.9112
V30	.2841	.3467	.3296	.4240	.5412	-.0941	.8365	.8364	.9112	1.0000
V31	.2319	.3282	.3046	.3816	.4772	-.1262	.8607	.7279	.8292	.9667
V32	.4378	.5571	.5330	.5840	.6124	-.0393	.7891	.5111	.6577	.8551
V33	.5497	.6810	.6666	.7058	.7383	-.1356	.7649	.4170	.5797	.7645
V34	.5999	.7169	.6913	.7040	.6757	-.0407	.6476	.3788	.5419	.7086
V35	.8589	.9280	.9224	.9345	.8932	.1055	.4740	.1992	.3500	.4891
V36	.7859	.8771	.8847	.9279	.9367	.0118	.5544	.2442	.3929	.5663
V37	.6354	.6462	.6383	.6804	.7990	-.2421	.3175	.3609	.3944	.4045
V38	-.1846	-.1994	-.2397	-.2209	-.1076	-.3566	-.1457	.0513	-.0285	-.1211

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

1 81/02/23. 18.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V31	V32	V33	V34	V35	V36	V37	V38	V101	V102
V1	-.1249	-.0838	-.1814	-.1233	.1793	.1122	.3156	.1384	-.7592	-.5287
V2	-.6583	-.4807	-.4984	-.4180	.0375	-.0899	.0610	.0989	-.7771	-.9050
V3	-.7137	-.5778	-.6091	-.5374	-.1251	-.2402	-.0678	.1246	-.7454	-.8938
V4	.7246	.5914	.6218	.5470	.1365	.2564	.0720	-.1386	.7524	.9015
V5	.4671	.3038	.4646	.4001	.1006	.2009	-.0721	-.2369	.7749	.8208
V6	-.8039	-.7331	-.6585	-.6515	-.2142	-.2186	.1969	.3241	-.6770	-.6980
V7	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V8	.0779	-.0757	-.1217	-.1464	-.2490	-.1826	.3097	.6547	-.2006	.0504
V9	-.7332	-.6477	-.6424	-.6012	-.1913	-.2490	.1506	.3397	-.8073	-.8537
V10	.6242	.4439	.4706	.3418	-.0182	.1195	-.0779	-.1715	.7965	.9038
V11	.3756	.3903	.1939	.2791	.0664	-.0371	-.2265	-.1173	-.1229	-.1965
V12	-.6787	-.4988	-.4997	-.3811	.0099	-.1151	.1077	.1860	-.7856	-.8840
V13	.0050	.1385	.1877	.2820	.5745	.4692	.5903	.0506	-.5666	-.4016
V14	.1306	.0012	-.1175	-.1020	-.1477	-.1601	-.2845	-.1400	-.0627	.1200
V15	.1822	.0683	.0250	.0358	.1737	.0831	.1661	-.0640	-.3551	-.0441
V16	.2712	.1449	.1101	.1250	.2268	.1753	.4354	.1148	-.4500	-.0548
V17	.3007	.2156	.2105	.2251	.3492	.2973	.5007	.0657	-.3952	-.0295
V18	.2849	.2548	.2776	.2988	.4682	.4105	.5642	.0217	-.3854	-.0617
V19	.2361	.3184	.3943	.4322	.6635	.5932	.6343	-.0593	-.3226	-.1137

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)
81/02/23. 18.37.52.

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FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

- - - - - - - - - - - - PEARSON CORRELATION COEFFICIENTS - - - - - - - - - - - -

	V31	V32	V33	V34	V35	V36	V37	V38	V101	V102
V20	.2653	.4193	.5297	.5790	.7739	.7196	.6380	-.1458	.1585	-.0268
V21	.2319	.4378	.5497	.5999	.8589	.7859	.6354	-.1846	-.1834	-.1311
V22	.3282	.5571	.6810	.7169	.9280	.8771	.6462	-.1994	-.0305	-.0269
V23	.3046	.5330	.6666	.6913	.9224	.8847	.6383	-.2397	-.0114	-.0087
V24	.3816	.5840	.7058	.7040	.9345	.9279	.6804	-.2209	.0005	.0436
V25	.4772	.6124	.7383	.6757	.8932	.9367	.7990	-.1076	.0253	.1294
V26	-.1262	-.0393	-.1356	-.0407	.1055	.0118	-.2421	-.3566	-.3620	-.4353
V27	.8607	.7891	.7649	.6476	.4740	.5544	.3175	-.1457	.4246	.5412
V28	.7279	.5111	.4170	.3788	.1992	.2442	.3609	.0513	-.0538	.4012
V29	.8292	.6577	.5797	.5419	.3500	.3929	.3944	-.0285	.0594	.4662
V30	.9667	.8551	.7645	.7086	.4891	.5663	.4045	-.1211	.1944	.5148
V31	1.0000	.9301	.8448	.8052	.5014	.5675	.3081	-.1717	.3587	.5760
V32	.9301	1.0000	.9618	.9552	.7372	.7677	.4040	-.2294	.3506	.4289
V33	.8448	.9618	1.0000	.9772	.8215	.8596	.5000	-.2023	.4328	.4492
V34	.8052	.9552	.9772	1.0000	.8301	.8334	.4571	-.2327	.3669	.3639
V35	.5014	.7372	.8215	.8301	1.0000	.9713	.6804	-.1800	.0190	-.0144
V36	.5675	.7677	.8596	.8334	.9713	1.0000	.7242	-.1741	.1009	.1171
V37	.3081	.4040	.5000	.4571	.6804	.7242	1.0000	.4303	-.3339	-.1877
V38	-.1717	-.2294	-.2023	-.2327	-.1800	-.1741	.4303	1.0000	-.3516	-.3217

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

81/02/23. 18.37.52.

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FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V103	V104	V105	V106	V107	V108	V109	V110	V111	V112
V1	-.2149	-.4008	.4692	.1256	.0397	.4340	.3447	.2045	.1954	99.0000
V2	-.7100	-.8723	.1266	.3636	.2966	.3815	.2510	.0921	.1490	99.0000
V3	-.7314	-.8977	.1147	.3136	.3694	.2424	.3021	.1219	.1843	99.0000
V4	.7388	.8959	-.1170	-.3152	-.3728	-.2311	-.3176	-.1339	-.1998	99.0000
V5	.5877	.7955	-.2101	-.2463	-.3309	-.1895	-.2153	.1754	-.3248	99.0000
V6	-.6380	-.8884	-.4128	.4657	.4706	.2746	.4342	-.0517	.4443	99.0000
V7	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V8	.3486	.1457	.0986	.1870	.4111	-.2260	.4972	.2436	.7179	99.0000
V9	-.7037	-.9393	-.1496	.4263	.4711	.2405	.3807	-.1043	.4517	99.0000
V10	.7094	.8252	-.1235	-.3505	-.3218	-.2128	-.3419	-.1244	-.2409	99.0000
V11	-.1291	.0973	.6367	-.2313	-.1419	-.2213	-.2053	-.0608	-.1608	99.0000
V12	-.6982	-.8443	.0398	.3823	.3412	.2442	.3716	.1338	.2620	99.0000
V13	-.2210	-.1475	.1567	.2738	-.2322	.6073	.1529	.0721	.0840	99.0000
V14	.0374	.3618	.5083	-.2765	-.2193	-.0745	.4314	.9705	-.2023	99.0000
V15	-.0575	.2008	.4336	-.2105	-.5212	.4174	.0859	.1346	-.0877	99.0000
V16	-.0110	.2270	.3106	-.0930	-.4421	.4061	.2706	.0948	.1778	99.0000
V17	.0305	.2436	.2671	-.0468	-.4698	.4876	.1807	.0444	.1135	99.0000
V18	.0231	.1985	.2213	.0235	-.4683	.5700	.1106	.0005	.0631	99.0000
V19	.0170	.1115	.1241	.1561	-.4273	.6865	-.0406	-.0792	-.0421	99.0000

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

1 01/02/23. 18.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V103	V104	V105	V106	V107	V108	V109	V110	V111	V112
V20	.0819	.1335	-.0033	.1982	-.4092	.6561	-.1993	-.1658	-.1624	99.0000
V21	.0529	.0539	.0722	.2759	-.3524	.7462	-.2487	-.1168	-.2175	99.0000
V22	.1846	.1440	.0500	.3180	-.3067	.7206	-.3794	-.1462	-.2734	99.0000
V23	.1744	.1254	-.0010	.3103	-.3196	.7491	-.3760	-.1456	-.3055	99.0000
V24	.2408	.1832	.0255	.3320	-.3011	.7086	-.3692	-.0870	-.3029	99.0000
V25	.3476	.2186	-.0552	.3652	-.2570	.8331	-.4308	-.3055	-.1730	99.0000
V26	-.5813	-.1891	.3512	-.0667	-.2085	.1463	.2655	.6551	-.3620	99.0000
V27	.6589	.6699	.2754	-.0985	-.3337	.2846	-.5564	-.2972	-.2497	99.0000
V28	.3805	.6736	.3704	-.2795	-.5097	.1589	.0922	.0815	.0591	99.0000
V29	.4793	.7616	.4006	-.2550	-.5483	.2150	-.0348	.0850	-.0536	99.0000
V30	.5825	.7816	.4277	-.1902	-.4737	.2422	-.2283	.0387	-.1915	99.0000
V31	.6449	.8222	.4108	-.2176	-.4453	.1081	-.3731	-.0535	-.2648	99.0000
V32	.5919	.6686	.3625	-.0425	-.3757	.2437	-.5437	-.1711	-.3476	99.0000
V33	.6347	.6220	.1717	.0943	-.3126	.3371	-.6428	-.2908	-.3340	99.0000
V34	.5427	.5739	.2226	.0611	-.3392	.2793	-.5960	-.2535	-.3498	99.0000
V35	.2947	.1790	.1731	.3666	-.2215	.7339	-.5416	-.2471	-.2895	99.0000
V36	.3762	.2441	.0538	.3618	-.2130	.7218	-.5415	-.2817	-.2777	99.0000
V37	.2192	-.0199	-.0912	.6672	.1865	.6656	-.1186	-.3381	.4249	99.0000
V38	.1187	-.1765	-.0274	.6946	.8096	-.1000	.1460	-.1069	.9082	99.0000

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

1 81/02/23. 18.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V113	V114	V115	V116	V117	V118	V119	V120	V121	V122
V1	.1563	.4518	.1611	-.3278	-.2155	-.6230	.4244	-.2099	.1554	.3547
V2	.3916	.2537	-.0479	-.3255	-.0972	-.5429	.1871	.0029	-.5140	.1062
V3	.3671	.3126	-.0014	-.3627	.0066	-.5453	.1618	.0555	-.5078	.1307
V4	-.3685	-.3138	-.0074	.3440	-.0196	.5495	-.1576	-.0826	.5195	-.1377
V5	-.3084	-.4569	-.0695	.4462	-.0572	.5529	-.1370	.0317	.3346	-.2006
V6	.5152	.1821	-.0048	-.1321	-.1699	-.4291	.1129	.2536	-.3269	.1185
V7	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V8	.2597	.4730	.3515	-.0055	-.0274	-.2042	.1512	.1319	.7016	.4070
V9	.4853	.3328	.0093	-.2931	-.0724	-.5056	.0931	.1560	-.3988	.1462
V10	-.3742	-.4532	.0195	.1982	.0357	.5079	-.1061	.0122	.4263	-.1555
V11	-.2334	.2259	-.1868	-.3974	.2040	.1697	-.3311	-.3706	-.2215	-.2028
V12	.4064	.4261	.0049	-.1465	-.0632	-.5349	.1517	.0368	-.4009	.1835
V13	.1810	-.0513	-.1727	.1354	-.4406	-.1860	.0942	-.1127	-.1656	-.0162
V14	-.2730	-.4315	-.2681	-.1785	-.3621	.5691	-.1225	-.5042	.4937	-.3448
V15	-.2659	-.3061	.0736	.1683	-.0608	-.1621	.1428	.1395	-.2121	.0653
V16	-.1531	-.2272	-.0169	.1442	-.2445	-.0688	.0226	.1142	-.0292	.0150
V17	-.1242	-.2832	-.0555	.1683	-.3104	-.0486	.0477	.0677	-.0259	-.0142
V18	-.0679	-.3072	-.1023	.1684	-.3820	-.0559	.0757	.0106	-.0480	-.0400
V19	.0430	-.3181	-.1717	.1831	-.4716	-.0657	.1239	-.0900	-.0848	-.0748

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

1 81/02/23. 18.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V113	V114	V115	V116	V117	V118	V119	V120	V121	V122
V20	.0688	-.2063	-.2230	.2536	-.5015	.0181	.1076	-.2182	-.0315	-.1145
V21	.1482	-.3037	-.2759	.1102	-.5600	-.0256	.1516	-.2944	-.0848	-.1487
V22	.1861	-.3201	-.3195	.0744	-.6015	.0717	.1292	-.4016	.0057	-.1996
V23	.1790	-.3654	-.3386	.0628	-.6304	.0780	.1409	-.4023	-.0006	-.2206
V24	.2044	-.4083	-.3993	-.0433	-.7280	.1469	.1120	-.4905	.0755	-.2826
V25	.2512	-.5243	-.4229	-.1669	-.8166	.2071	.0854	-.4835	.1610	-.3309
V26	-.1091	-.2115	-.6807	-.3879	-.3085	.2791	-.4581	-.3575	-.7597	-.6225
V27	-.1512	-.4810	-.2517	-.3385	-.3508	.4395	-.0857	-.4541	.3483	-.3270
V28	-.3337	-.2506	-.1072	.0262	-.2589	.3071	-.1679	-.1620	.3222	-.1427
V29	-.3276	-.3101	-.1659	.0112	-.3278	.3692	-.1549	-.2697	.3592	-.1973
V30	-.2617	-.2927	-.3189	-.2351	-.4558	.4939	-.2025	-.5759	.4525	-.3348
V31	-.2893	-.2225	-.2837	-.1874	-.3345	.5276	-.2155	-.5999	.4677	-.3157
V32	-.1365	-.1821	-.3574	-.2115	-.4214	.4730	-.1599	-.7297	.3917	-.3380
V33	-.0130	-.2845	-.3533	-.1085	-.4869	.4644	-.0948	-.6628	.3861	-.3312
V34	-.0514	-.1629	-.3342	-.0457	-.4151	.4157	-.1079	-.6648	.3303	-.2913
V35	.2477	-.2983	-.4210	-.2198	-.6854	.1573	.0756	-.6412	.0918	-.2992
V36	.2463	-.3542	-.4805	-.2524	-.7782	.2738	.0212	-.7030	.2069	-.3694
V37	.6007	-.1626	-.3723	-.2959	-.8229	.1168	-.0634	-.3484	.2434	-.2271
V38	.7511	.3490	.1699	-.0946	-.0418	-.1111	-.0878	.2333	.1931	.2086

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

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FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY 81/02/23. 18.37.52.

PEARSON CORRELATION COEFFICIENTS

	V123	V124	V125	V126	V127	V128	V129	V130	V131	V132
V1	-.3547	-.3858	-.3802	.1807	.2155	.1090	.3269	.1196	.1101	.2816
V2	-.3603	-.2551	-.2489	.1375	.0874	.1466	.1975	.0824	.0918	.1452
V3	-.3548	-.2452	-.2535	.1696	.1162	.1793	.2252	.1081	.1167	.1852
V4	.3426	.2589	.2703	-.1846	-.1300	-.1943	-.1928	-.1221	-.1318	-.2041
V5	.0992	.0604	.0556	-.3029	.1666	-.3158	-.3521	-.2216	-.2312	.0230
V6	-.1861	-.4918	-.4269	.4163	-.0375	.4358	.0121	.3121	.3535	.1467
V7	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V8	-.1114	-.5081	-.5803	.7000	.3068	.6951	-.2681	.6497	.6153	.5642
V9	-.1608	-.3485	-.3093	.4264	-.0885	.4443	.1344	.3257	.3534	.1027
V10	.4014	.4142	.3918	-.2235	-.1290	-.2338	-.0476	-.1563	-.1415	-.2191
V11	.0778	.4225	.3513	-.1500	-.0681	-.1563	.2079	-.1123	-.1698	-.1283
V12	-.4149	-.4728	-.4408	.2428	.1391	.2541	.0211	.1700	.1628	.2370
V13	-.0757	-.3847	-.3361	.0744	.0914	.0790	-.2988	.0448	.0476	.1190
V14	-.4025	-.4851	-.6045	-.1862	.9734	-.1955	-.2737	-.1402	-.1769	.8267
V15	.4323	.0157	-.0680	-.0687	.1521	-.0593	-.1635	-.0695	.0078	.1223
V16	.4517	-.2012	-.2355	.1603	.1295	.1692	-.3625	.1126	.1631	.1908
V17	.4176	-.1634	-.1802	.1009	.0749	.1077	-.3485	.0642	.1119	.1145
V18	.3436	-.1507	-.1468	.0499	.0258	.0554	-.3175	.0200	.0624	.0474
V19	.1735	-.1165	-.0744	-.0498	-.0649	-.0480	-.2549	-.0613	-.0339	-.0794

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

1 81/02/23. 18.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V123	V124	V125	V126	V127	V128	V129	V130	V131	V132
V20	.0366	-.0832	-.0034	-.1580	-.1616	-.1577	-.1905	-.1452	-.1364	-.2137
V21	-.1095	-.0385	.0376	-.2124	-.1204	-.2179	-.1038	-.1856	-.1911	-.2010
V22	-.2017	.0255	.1135	-.2550	-.1523	-.2658	-.0471	-.1974	-.2212	-.2514
V23	-.2114	.0299	.1229	-.2911	-.1569	-.3012	-.0193	-.2376	-.2574	-.2699
V24	-.2742	.0004	.0922	-.2825	-.0967	-.2945	.0223	-.2168	-.2451	-.2116
V25	-.0561	.1484	.2497	-.1557	-.3046	-.1660	.1106	-.1009	-.1096	-.3537
V26	-.4427	-.2703	-.3324	-.3717	.6202	-.3748	-.1727	-.3531	-.4065	.4253
V27	.2725	.6178	.6118	-.2229	-.2985	-.2407	.2767	-.1324	-.1486	-.3810
V28	.4499	-.0261	-.0641	.0581	.1126	.0595	-.2413	.0604	.0705	.1280
V29	.3590	.0429	.0130	-.0475	.1091	-.0522	-.2109	-.0177	-.0239	.0780
V30	.1189	.1738	.1680	-.1741	.0479	-.1863	.0361	-.1066	-.1536	-.0350
V31	.0985	.3104	.3102	-.2419	-.0510	-.2576	.0834	-.1560	-.2170	-.1569
V32	-.0863	.3643	.4041	-.3184	-.1778	-.3382	.1714	-.2153	-.2950	-.3080
V33	-.0791	.3840	.4533	-.2989	-.2959	-.3198	.1371	-.1884	-.2545	-.4107
V34	-.1221	.3275	.3971	-.3209	-.2611	-.3402	.0897	-.2203	-.2968	-.3861
V35	-.2725	.2143	.3039	-.2605	-.2549	-.2777	.1815	-.1751	-.2255	-.3534
V36	-.2663	.1932	.3018	-.2497	-.2898	-.2654	.2133	-.1657	-.2175	-.3810
V37	-.0573	-.1898	-.0690	.4303	-.2897	.4225	-.1063	.4357	.4059	-.1024
V38	-.0287	-.4076	-.3949	.9714	-.0101	.9663	-.3084	.9995	.9902	.3821

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

81/02/23. 18.37.52.

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FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V133	V134	V135	V136	V137	V138	V139	V140	V141	V201
V1	.2346	.2631	.4659	99.0000	.1885	99.0000	.2619	.2326	.4349	-.3271
V2	.1027	.1951	.3429	99.0000	.1755	99.0000	.4828	.1047	.4936	-.8850
V3	.1352	.2177	.3406	99.0000	.1320	99.0000	.4641	.1353	.5005	-.8804
V4	-.1510	-.2239	-.3555	99.0000	-.1289	99.0000	-.4587	-.1487	-.5079	.8808
V5	.1298	-.0353	-.3074	99.0000	-.2003	99.0000	-.3851	.1435	-.2258	.7340
V6	.0141	.2248	.5203	99.0000	.3836	99.0000	.5765	-.0068	.5074	-.6426
V7	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V8	.3934	.0111	.6349	99.0000	-.0127	99.0000	.1710	.2868	.4096	.3150
V9	-.0358	.1613	.4789	99.0000	.3223	99.0000	.5448	-.0616	.4340	-.7846
V10	-.1527	-.2270	-.3856	99.0000	-.1567	99.0000	-.3669	-.1487	-.4418	.8740
V11	-.0891	-.1283	-.2740	99.0000	-.1872	99.0000	-.2864	-.0787	-.3159	-.2335
V12	.1655	.2463	.4239	99.0000	.1834	99.0000	.4065	.1607	.4863	-.8495
V13	.0985	.1273	.3646	99.0000	.3321	99.0000	.1262	.1025	.2268	-.3201
V14	.9456	.6035	.2510	99.0000	-.2238	99.0000	-.2476	.9567	.5587	.1293
V15	.1481	.3187	.1439	99.0000	.1441	99.0000	-.1970	.1530	-.0094	-.0093
V16	.1501	.2073	.4055	99.0000	.3590	99.0000	-.1574	.1474	.0498	.0735
V17	.0882	.1429	.3509	99.0000	.3636	99.0000	-.1282	.0903	.0229	.0885
V18	.0325	.0915	.3148	99.0000	.3781	99.0000	-.0701	.0407	.0262	.0460
V19	-.0710	-.0190	.2108	99.0000	.3534	99.0000	.0333	-.0546	.0205	-.0382

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

1 81/02/23. 18.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V133	V134	V135	V136	V137	V138	V139	V140	V141	V201
V20	-.1813	-.0845	.0316	99.0000	.2821	99.0000	.0254	-.1580	-.0855	.0046
V21	-.1474	-.1491	.0300	99.0000	.2429	99.0000	.1394	-.1222	.0263	-.1001
V22	-.1838	-.2446	-.0784	99.0000	.1476	99.0000	.1677	-.1694	-.0041	-.0062
V23	-.1933	-.2345	-.0836	99.0000	.1802	99.0000	.1813	-.1686	.0080	.0065
V24	-.1317	-.2179	-.0547	99.0000	.1776	99.0000	.2279	-.1160	.0865	.0817
V25	-.3210	-.3639	-.0345	99.0000	.2760	99.0000	.3124	-.3248	-.0028	.2152
V26	.5648	.4430	.1070	99.0000	.0539	99.0000	-.1007	.6376	.4251	-.5505
V27	-.3215	-.4716	-.3292	99.0000	-.0431	99.0000	-.0708	-.3337	-.3477	.6074
V28	.1206	.0966	.1634	99.0000	.1966	99.0000	-.3635	.1112	-.1681	.5356
V29	.1037	.0094	.0689	99.0000	.1352	99.0000	-.3588	.0987	-.1871	.5870
V30	.0259	-.1354	-.0958	99.0000	.0483	99.0000	-.2677	.0246	-.1955	.6289
V31	-.0813	-.2560	-.2699	99.0000	-.0738	99.0000	-.3284	-.0805	-.3457	.6501
V32	-.2180	-.4007	-.3671	99.0000	-.1009	99.0000	-.1886	-.2134	-.3520	.4757
V33	-.3316	-.5025	-.3966	99.0000	-.0888	99.0000	-.0658	-.3379	-.3561	.4801
V34	-.3016	-.4559	-.3956	99.0000	-.0968	99.0000	-.1428	-.2956	-.3826	.3803
V35	-.2862	-.4197	-.1741	99.0000	.0782	99.0000	.2600	-.2879	-.0381	.0339
V36	-.3196	-.4208	-.1817	99.0000	.1289	99.0000	.2667	-.3210	-.0566	.1779
V37	-.2326	-.4111	.3896	99.0000	.3566	99.0000	.5578	-.3210	.2320	.0190
V38	.1232	-.1491	.4877	99.0000	-.1941	99.0000	.6067	-.1017	.4249	-.1548

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

1 81/02/23. 18.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V202	V203	V204	V205	V206	V207	V208	V209	V210	V211
V1	.1721	-.3309	.3189	-.3489	-.1381	.1946	.2432	-.0261	.1017	.6450
V2	.5633	-.8638	.2404	-.4304	-.0687	-.4009	.2155	.1143	.1153	.2274
V3	.5602	-.8430	.3097	-.4335	-.0387	-.3805	.2016	.1436	.1382	.1177
V4	-.5428	.8512	-.3158	.4559	.0289	.3882	-.2245	-.1622	-.1517	-.0959
V5	-.5083	.6875	-.6478	.3068	.4043	.1202	.0295	.2475	.2319	-.2116
V6	.1422	-.5446	.2069	-.7127	-.0149	-.0314	.4901	.0445	.1762	.2012
V7	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V8	-.7753	.3511	.2502	-.5002	-.0313	.7106	.4972	.1056	.2728	-.0005
V9	.3262	-.7035	.4571	-.6051	-.2047	-.1115	.3045	-.0707	.0096	.1836
V10	-.4386	.8594	-.3148	.4991	.1493	.3029	-.2977	-.1094	-.1377	-.1308
V11	.4293	-.3019	.5297	.4659	-.4258	-.3191	-.5538	-.2145	-.3576	-.1936
V12	.3862	-.8257	.2458	-.5639	-.0933	-.2636	.3730	.1391	.1866	.1581
V13	-.0344	-.3750	-.0467	-.3802	-.1212	-.1308	.4009	.0495	.1125	.4790
V14	-.2830	.0672	-.2831	-.1652	.7300	-.1755	.5048	.8779	.8745	-.0551
V15	-.0676	-.0377	.1741	-.1603	.1604	-.1252	.2110	.0949	.0210	.3728
V16	-.3570	.0508	.2561	-.3443	-.0332	.0912	.3842	.0324	.0627	.3917
V17	-.3240	.0545	.1436	-.2888	-.0506	.0662	.3431	-.0015	.0289	.4405
V18	-.2529	.0026	.0461	-.2577	-.0783	.0218	.3130	-.0306	.0050	.4966
V19	-.1050	-.0991	-.1509	-.1749	-.1234	-.0694	.2316	-.0771	-.0419	.5413

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

01/02/23. 18.37.52.

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FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V202	V203	V204	V205	V206	V207	V208	V209	V210	V211
V20	-.0328	-.0677	-.3186	-.0288	-.1613	-.0594	.1142	-.1604	-.1115	.5374
V21	.1040	-.1886	-.3969	.0215	-.1513	-.1860	.0585	-.1029	-.0738	.5532
V22	.1032	-.1081	-.5144	.1650	-.1631	-.1644	-.0533	-.1375	-.1084	.5289
V23	.1186	-.0903	-.5605	.1669	-.1314	-.1684	-.0480	-.1264	-.0863	.5556
V24	.0644	-.0186	-.5989	.1945	-.0928	-.1259	-.0410	-.0946	-.0263	.6158
V25	-.0199	.1418	-.4594	.2360	-.2401	.0314	-.1512	-.3129	-.2211	.6855
V26	.3755	-.6278	-.1380	-.0731	.3285	-.7653	.2399	.6554	.6039	-.0811
V27	-.0852	.5367	-.1327	.6828	-.2597	.1398	-.5912	-.3904	-.4192	.2855
V28	-.5338	.4916	.2058	.0515	-.0804	.3189	.0992	-.0827	-.0241	.3138
V29	-.4921	.5164	.0494	.1850	-.0777	.2673	.0100	-.0777	-.0327	.3322
V30	-.3269	.5347	-.0717	.4585	-.1719	.2446	-.2454	-.1713	-.1065	.3848
V31	-.2419	.5466	-.1032	.6201	-.2451	.2206	-.4196	-.2541	-.2288	.2524
V32	-.0226	.3503	-.2403	.7014	-.3647	.0913	-.5359	-.3447	-.3316	.3077
V33	-.0387	.3626	-.4012	.6738	-.3519	.0918	-.5194	-.3900	-.3769	.3233
V34	.0168	.2536	-.3504	.6423	-.3883	.0419	-.4947	-.3680	-.3644	.2792
V35	.2175	-.0818	-.4414	.3972	-.3331	-.1457	-.3216	-.2968	-.2700	.5677
V36	.1189	.0746	-.4837	.4263	-.3286	-.0218	-.3245	-.3441	-.2652	.6153
V37	-.2971	-.0136	-.0374	-.1710	-.4853	.2475	.1101	-.3686	-.2046	.5389
V38	-.5180	-.1076	.3904	-.4997	-.1949	.3403	.3301	-.0907	-.0488	-.1689

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

1 81/02/23. 10.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V212	V213	V214	V215	V216	V217	V218	V219	V220	V221
V1	-.2225	-.1500	.5660	-.1385	.1053	.2605	-.5259	.1828	-.8624	-.7034
V2	-.0295	-.0643	.1668	.0946	.0224	.2246	-.0239	.2417	-.6893	-.7034
V3	.0631	-.0460	.0583	.1496	-.0391	.2640	.0262	.2649	-.6759	-.7304
V4	-.0574	.0388	-.0370	-.1643	.0222	-.2775	-.0164	-.2911	.6728	.7366
V5	.2089	-.0382	-.0883	.2751	.2339	-.4238	.1485	-.1030	.6754	.6871
V6	-.0343	.1693	.1937	-.0063	.4537	.5955	.0513	.3676	-.5227	-.5074
V7	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V8	.0576	.3695	.0017	.0344	.4709	.6170	-.3626	.6039	-.3241	-.2997
V9	-.1018	.1561	.1165	-.1150	.1728	.5865	-.0232	.3156	-.6313	-.6414
V10	.0103	.0085	-.0619	-.1222	-.0833	-.3226	-.0069	-.3682	.7552	.7739
V11	.0559	-.0355	-.3325	-.1622	-.7830	-.2098	.0205	-.2090	.0255	-.0454
V12	-.0177	-.0060	.1072	.1453	.1874	.3513	.0048	.3972	-.7642	-.7735
V13	-.4116	-.0579	.4405	-.1218	.4671	.1239	-.3680	.2293	-.3603	-.2138
V14	.5711	-.1903	.0017	.8137	.2742	-.2767	-.2125	.4419	-.0363	-.0664
V15	-.5838	-.1666	.3231	-.1883	.1805	-.0080	-.7784	.0181	.0012	.0454
V16	-.5687	-.0360	.3331	-.2752	.4094	.2518	-.7454	.1717	-.0317	.0609
V17	-.5937	-.0578	.3920	-.2982	.4194	.1753	-.6995	.1106	-.0103	.1069
V18	-.6006	-.0811	.4548	-.3087	.4268	.1149	-.6324	.0660	-.0383	.1036
V19	-.5715	-.1152	.5167	-.2928	.4061	-.0168	-.4538	-.0123	-.0862	.0848

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

1 01/02/23. 18.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V212	V213	V214	V215	V216	V217	V218	V219	V220	V221
V20	-.5002	-.1166	.5332	-.2945	.3576	-.1470	-.2535	-.1178	-.0554	.1482
V21	-.4005	-.1571	.5498	-.2115	.2765	-.2492	-.1768	-.1316	-.1197	.0794
V22	-.2974	-.1124	.5390	-.1995	.2096	-.3568	-.0597	-.1916	-.0413	.1726
V23	-.2739	-.1429	.5755	-.1870	.2285	-.3761	-.0286	-.2248	-.0274	.1961
V24	-.1711	-.1016	.6403	-.1672	.2511	-.3952	-.0276	-.2172	.0072	.2614
V25	-.2949	.0202	.6915	-.4361	.2153	-.2603	-.1003	-.3262	.1367	.4155
V26	.5863	-.2514	-.0949	.6626	-.0217	-.3488	.2592	.2218	-.0767	-.1179
V27	-.1420	.0293	.2566	-.4696	-.3686	-.4028	-.1504	-.5400	.5226	.6638
V28	-.3178	.0433	.2624	-.3287	.1833	.0661	-.6125	-.0232	.2870	.4216
V29	-.2660	.0064	.2932	-.2942	.1311	-.0953	-.5367	-.0961	.3344	.4890
V30	-.0312	.0130	.3455	-.2997	-.0916	-.2940	-.2945	-.2667	.3555	.5614
V31	-.0058	.0025	.2151	-.3057	-.2631	-.3966	-.1554	-.3606	.4048	.5787
V32	-.0187	-.0229	.2705	-.3305	-.3361	-.5111	.0136	-.4358	.2896	.4891
V33	-.0949	.0218	.3147	-.3675	-.2249	-.5126	.0791	-.4549	.3367	.5439
V34	-.1060	-.0284	.2587	-.3226	-.2498	-.5097	.0944	-.4130	.2397	.4319
V35	-.1922	-.0413	.5480	-.3245	-.0536	-.4355	.0219	-.3323	-.0080	.2325
V36	-.1234	.0088	.6094	-.3716	.0035	-.4102	.0771	-.3778	.0827	.3639
V37	-.2677	.4268	.4950	-.5205	.4111	.3103	-.1514	.1199	-.0785	.1564
V38	-.0492	.8713	-.2102	-.1690	.3634	.7347	-.2239	.7145	-.1453	-.2048

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

1 81/02/23. 18.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V222	V223	V224	V225	V226	V227	V228	V229	V230	V231
V1	.4501	.0278	.4537	-.6273	.4784	.0750	-.3944	-.0598	-.2292	-.1137
V2	-.0100	.0231	.0143	-.5463	.0816	.0207	-.2364	-.4324	-.0558	-.5460
V3	-.1271	.0420	-.0877	-.5500	-.0355	.0016	-.2094	-.4381	-.0341	-.6267
V4	.1486	-.0304	.1092	.5546	.0565	-.0109	.2180	.4352	.0327	.6353
V5	.0405	-.1350	-.0174	.5212	-.0444	.2431	.2838	.3677	.2019	.5579
V6	.0341	-.5733	.1263	-.4186	.1518	.1434	.0707	-.0826	.0891	-.3803
V7	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V8	.0621	-.3973	.0105	-.2213	-.0276	.3715	-.1056	.4444	-.2240	-.0394
V9	-.0468	-.2867	.0388	-.4869	.0696	-.0060	-.0850	-.2569	-.0668	-.5353
V10	.1067	.0134	.0635	.5133	.0204	-.0472	.3175	.3864	.2915	.6557
V11	-.3284	.8210	-.3414	.1740	-.3390	-.3273	-.1748	-.4548	-.5065	-.3287
V12	-.0634	-.1219	-.0180	-.5403	.0251	.0900	-.2967	-.3205	-.2258	-.6169
V13	.3963	-.2248	.3646	-.1929	.4371	.1941	-.2109	.0131	-.2537	.1144
V14	-.0950	.0825	-.1412	.0074	-.1324	.6219	.3181	.1642	.0016	.6185
V15	.2663	-.0497	.3104	-.1751	.3453	.0415	-.2001	.0185	.1981	.5123
V16	.3211	-.2648	.3324	-.0795	.3661	.1081	-.0712	.2699	-.0405	.4680
V17	.3969	-.2588	.3884	-.0548	.4327	.1009	-.0710	.2665	-.0271	.5073
V18	.4646	-.2503	.4395	-.0578	.4964	.0953	-.0805	.2354	-.0345	.4964
V19	.5390	-.2054	.4825	-.0593	.5580	.0794	-.1167	.1528	-.0561	.4301

BIVARIATE CORRELATION MATRIX OF FUEL VARIBALES VERSUS ALL VARIABLES (Cont'd)

1 81/02/23. 18.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V222	V223	V224	V225	V226	V227	V228	V229	V230	V231
V20	.5740	-.1689	.5192	.0324	.5842	.0613	-.1179	.1042	-.1242	.4160
V21	.5882	-.0394	.4840	-.0154	.5759	.0787	-.1306	.0044	-.1093	.3173
V22	.6104	.0365	.4771	.0836	.5683	.1080	-.0930	-.0287	-.1321	.3348
V23	.6414	.0049	.5098	.0899	.6021	.1068	-.0431	-.0031	-.0829	.3604
V24	.7079	.0026	.5607	.1530	.6559	.2023	.0548	.0077	-.0853	.4223
V25	.7982	-.0693	.6529	.2262	.7447	.1120	.1972	.1000	-.0026	.5827
V26	-.2587	.3119	-.2852	.1463	-.2191	.3242	.2442	-.5107	-.3557	-.4416
V27	.4349	.4001	.2940	.4479	.3268	-.1352	.2424	.0967	.0429	.6273
V28	.3312	-.0647	.3206	.2934	.3117	.1186	.1332	.3561	-.1754	.6543
V29	.3909	.0386	.3364	.3541	.3411	.1330	.1297	.3283	-.1893	.6878
V30	.4679	.2690	.3650	.4844	.3766	.1232	.2230	.2021	-.2951	.6209
V31	.3698	.4136	.2582	.5279	.2590	.0100	.1502	.1392	-.3386	.5309
V32	.4345	.5162	.2867	.4803	.3135	-.0442	.0509	-.0093	-.4162	.3971
V33	.5028	.3823	.3404	.4719	.3798	-.0326	.0645	.0180	-.2968	.4599
V34	.4297	.4329	.2813	.4255	.3156	-.0684	-.0419	-.0227	-.4164	.3374
V35	.6528	.2807	.4763	.1754	.5750	.0459	-.0362	-.1510	-.2304	.2971
V36	.7255	.1817	.5600	.2893	.6447	.0866	.1209	-.0573	-.2222	.4052
V37	.5983	-.2982	.4625	.1426	.5455	.2577	.1839	.1155	-.3138	.2350
V38	-.1712	-.3664	-.1914	-.1000	-.1841	.4604	-.1017	-.1733	-.1821	-.2367

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

1 81/02/23. 18.37.52.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V232	V233	V234	V235	V236	V237	V238	V239	V240	V241
V1	-.2234	.7986	.3341	-.2239	-.3268	-.2085	-.0750	.3983	-.1658	-.0727
V2	-.7397	-.0104	.0450	.1783	-.2270	.0642	.0102	.4808	.0425	-.1892
V3	-.7810	-.0942	-.0343	.2418	-.2089	.1702	.1178	.5399	.0430	-.3057
V4	.7894	.0891	.0283	-.2444	.2222	-.1637	-.1176	-.5463	-.0229	.3068
V5	.7324	.1122	.0669	-.2079	.1826	-.2542	-.1952	-.7974	-.0894	.4614
V6	-.6002	.0778	.1604	-.0636	-.3057	-.1546	.5372	.3556	-.4118	-.5706
V7	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V8	.2897	.2880	.3651	-.2189	-.4845	-.3383	.2876	.1317	-.7002	-.2664
V9	-.7600	-.0374	.0376	.1037	-.2601	.0633	.4142	.6274	-.2131	-.5739
V10	.7358	.0887	.0136	-.3106	.1961	-.0942	.0163	-.5451	.0439	.1868
V11	-.3383	-.5452	-.5853	.5985	.4175	.7287	-.4312	.5549	.6303	.1312
V12	-.6966	-.0168	.0641	.2331	-.2530	-.0036	.0403	.4746	-.1270	-.2048
V13	-.1286	.3442	.3553	-.2116	-.2203	-.4556	-.3968	.0457	-.2591	.3452
V14	.7277	.0361	-.0271	-.1783	.2938	.0162	-.3452	-.2929	-.2177	.3940
V15	-.0217	.4136	.3309	-.5080	-.0872	-.3668	-.2104	.1220	-.1794	.1600
V16	.0456	.3928	.3433	-.4941	-.1971	-.4245	-.1427	.1681	-.4386	.0959
V17	.1028	.4338	.3835	-.5123	-.1996	-.4817	-.2171	.0686	-.3902	.1949
V18	.1100	.4563	.4111	-.5012	-.2060	-.5222	-.2855	.0006	-.3350	.2762
V19	.1233	.4685	.4371	-.4293	-.2058	-.5681	-.4138	-.1351	-.2007	.4291

BIVARIATE CORRELATION MATRIX OF FUEL VARIABLES VERSUS ALL VARIABLES (Cont'd)

01/02/23. 18.37.52.

1

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

- - - - - - - - - - - - PEARSON CORRELATION COEFFICIENTS - - - - - - - - - - - -

	V232	V233	V234	V235	V236	V237	V238	V239	V240	V241
V20	.2064	.4134	.3903	-.3386	-.0916	-.5642	-.4781	-.2844	-.0695	.5318
V21	.1586	.3959	.3800	-.2645	-.1315	-.5123	-.5966	-.3115	.0507	.6338
V22	.2677	.3608	.3475	-.2096	-.0677	-.4665	-.6645	-.4331	.1545	.7291
V23	.2797	.3664	.3521	-.2420	-.0662	-.4912	-.6317	-.4784	.1507	.7173
V24	.3327	.3537	.3392	-.2714	-.0296	-.4567	-.6346	-.5327	.1413	.7367
V25	.4011	.4037	.3762	-.4229	-.0508	-.4577	-.4474	-.4559	.1049	.5538
V26	-.6585	-.5985	-.6014	.6326	.4337	.5686	-.5113	.0384	.2308	.3931
V27	.5671	.0899	.0039	-.2467	.2035	.0530	-.3685	-.2821	.3862	.4045
V28	.3839	.1853	.1133	-.4074	.1016	-.1777	-.1883	-.0013	-.2667	.1820
V29	.4869	.1957	.1200	-.3781	.1279	-.1878	-.3519	-.1447	-.1508	.3677
V30	.5433	.0342	-.0342	-.2084	.2820	.0115	-.4810	-.2410	.1281	.4931
V31	.5796	-.0503	-.1179	-.0660	.3431	.1066	-.5410	-.2650	.2916	.5455
V32	.5270	-.0519	-.1022	.0590	.3316	.0959	-.7107	-.3178	.4739	.7021
V33	.6059	.0772	.0338	-.0313	.2481	-.0711	-.6741	-.4619	.4356	.7288
V34	.5193	.0185	-.0176	.0797	.2633	-.0348	-.7427	-.3851	.4565	.7584
V35	.2842	.2346	.2182	-.0902	.0341	-.2418	-.7358	-.3647	.3875	.7499
V36	.3861	.2113	.1951	-.1518	.1012	-.2443	-.6279	-.4467	.3363	.6885
V37	.1370	.3164	.3576	-.2508	-.2444	-.3643	-.1862	-.0314	-.2341	.1677
V38	-.1834	.1571	.2420	.0417	-.3062	99.0000	.3000	.3822	-.4670	-.3752

(COEFFICIENT / CASES / SIGNFICANCE) (99.0000 MEANS UNCOMPUTABLE)

FACTOR ANALYSIS OF SELECT FUEL VARIABLES

1 81/02/17. 09.36.11.

FILE FUEL (CREATION DATE = 81/02/17.) VARIABLES STUDY

VARIABLE	EST COMMUNALITY	FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT
V1	.70634	1	12.01741	48.1	48.1
V2	.98066	2	4.96733	19.9	67.9
V3	.99926	3	2.55910	10.2	78.2
V4	.99926	4	1.96799	7.9	86.0
V5	.87729	5	1.45358	5.8	91.9
V6	.92473	6	.85755	3.4	95.3
V8	.65474	7	.61443	2.5	97.7
V9	.92473	8	.38236	1.5	99.3
V10	.99126	9	.13575	.5	99.8
V11	.43474	10	.04449	.2	100.0
V12	.99126	11	.00000	.0	100.0
V13	.59030	12	.00000	.0	100.0
V14	.31549	13	.00000	.0	100.0
V27	.86065	14	.00000	.0	100.0
V28	.97787	15	.00000	.0	100.0
V29	.97787	16	.00000	.0	100.0
V30	.96669	17	.00000	.0	100.0
V31	.96669	18	-.00000	-.0	100.0
V32	.96177	19	-.00000	-.0	100.0
V33	.97723	20	-.00000	-.0	100.0
V34	.97723	21	-.00000	-.0	100.0
V35	.97131	22	-.00000	-.0	100.0
V36	.97131	23	-.00000	-.0	100.0
V37	.72425	24	-.00000	-.0	100.0
V38	.65474	25	-.00000	-.0	100.0

FACTOR ANALYSIS OF SELECT FUEL VARIABLES (Cont'd)

1

81/02/17. 09.36.11. PAGE 9

FILE FUEL (CREATION DATE = 81/02/17.) VARIABLES STUDY

FACTOR MATRIX USING PRINCIPAL FACTOR WITH ITERATIONS

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
V1	-.41130	.63560	.31241	.30755	.11258
V2	-.84720	.48014	-.14182	.13022	.06246
V3	-.90253	.33363	-.13189	.19134	-.01651
V4	.90908	-.32548	.11810	-.19023	.00342
V5	.73217	-.43829	-.00589	-.36693	.38509
V6	-.85650	.20655	.20239	-.32211	-.03475
V8	.01159	-.02802	.77344	-.07388	-.07481
V9	-.89553	.33492	.12967	-.02040	-.20767
V10	.82631	-.49291	.06255	-.13359	-.10981
V11	.13497	.16638	-.28139	.68499	-.27010
V12	-.85195	.47421	-.02141	.02501	.16193
V13	-.08472	.73093	.16861	-.10883	.39179
V14	.08187	-.14827	.20799	.27260	.51811
V27	.83716	.15111	-.04567	.12246	-.31951
V28	.65292	.19858	.54596	.29845	.10670
V29	.77180	.25044	.44034	.25746	.15713
V30	.86894	.30167	.23259	.26746	.01873
V31	.92675	.23171	.05941	.26749	-.07513
V32	.84955	.43095	-.18846	.12521	-.07645
V33	.84234	.43982	-.23962	-.14306	-.07883
V34	.77429	.48769	-.28334	-.07198	-.00263
V35	.43994	.80225	-.30201	-.24859	.09272
V36	.52473	.73223	-.23369	-.33563	.04047
V37	.22376	.74348	.36911	-.43656	-.20118
V38	-.21632	.08264	.59606	-.19473	-.40022

ITERATIVE PROCEDURE STOPPED AFTER 2 ITERATIONS BECAUSE COMMUNALITIES EXCEED ONE.

VARIABLE	COMMUNALITY
V1	.77802
V2	.98926
V3	.98014
V4	.98250
V5	1.01114
V6	.92217
V8	.61019
V9	.97451
V10	.95957
V11	.66725
V12	.97801
V13	.73521
V14	.41470
V27	.84284
V28	.86427
V29	.94327
V30	.97204
V31	.99329
V32	.96450
V33	.98707
V34	.92284
V35	.99875
V36	.98040
V37	.97012
V38	.60700

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT
1	11.97367	54.3	54.3
2	4.87728	22.1	76.4
3	2.32257	10.5	87.0
4	1.76015	8.0	94.9
5	1.11537	5.1	100.0

FACTOR ANALYSIS OF SELECT FUEL VARIABLES (Cont'd)

1

FILE FUEL (CREATION DATE = 81/02/17.) VARIABLES STUDY

VARIMAX ROTATED FACTOR MATRIX
AFTER ROTATION WITH KAISER NORMALIZATION

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
V1	-.75284	.15970	.13826	.27294	.30353
V2	-.97866	-.05976	-.07934	-.10583	-.10205
V3	-.94593	-.22712	-.02729	-.09619	-.15418
V4	.94674	.23824	.03866	.09042	.14058
V5	.88092	.14900	-.33911	-.16595	.26529
V6	-.72097	-.21143	-.47595	.27025	-.24104
V8	.06332	-.12663	-.10120	.72318	.23858
V9	-.87870	-.21323	-.13330	.24785	-.27880
V10	.97137	.05098	.09942	.05366	.02536
V11	-.12041	.03498	.77621	-.22141	-.00175
V12	-.96071	-.05157	-.22671	-.02436	-.01973
V13	-.48394	.55881	-.21885	.11275	.35796
V14	.06430	-.16577	-.04057	-.09366	.61046
V27	.56895	.50087	.50750	.09857	-.03155
V28	.34588	.31575	.34642	.42507	.58673
V29	.41297	.44891	.33883	.32564	.59192
V30	.46239	.56382	.46674	.20516	.42473
V31	.55013	.56195	.53509	.08045	.28648
V32	.39906	.76333	.44849	-.08691	.11781
V33	.44312	.85317	.23411	-.08738	-.01912
V34	.34124	.84680	.24792	-.16203	.04010
V35	-.07278	.98589	.00912	-.14523	-.01735
V36	.05736	.98487	-.02988	-.05929	-.05230
V37	-.13636	.75946	-.13814	.58977	-.08859
V38	-.13813	-.10490	-.07623	.73422	-.17898

TRANSFORMATION MATRIX

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
FACTOR 1	.79014	.50650	.27569	.00562	.20761
FACTOR 2	-.57240	.79312	.13204	.14755	.06420
FACTOR 3	.02318	-.16587	-.09796	.88533	.42256
FACTOR 4	-.20826	-.29109	.81897	-.15869	.41952
FACTOR 5	-.06428	.04671	-.47565	-.41136	.77345

FACTOR SCORE COEFFICIENTS ARE INDETERMINATE

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V101	V102	V103	V104	V105	V106	V107	V108	V109	V110
V101	1.0000	.8393	.6514	.6258	-.2343	-.3192	-.2004	-.3516	-.5746	-.1922
V102	.8393	1.0000	.7439	.8366	-.1074	-.4977	-.4311	-.2711	-.3384	-.0343
V103	.6514	.7439	1.0000	.7543	.1743	-.0059	-.0227	-.0164	-.5137	-.1290
V104	.6258	.8366	.7543	1.0000	.3039	-.4026	-.4676	-.1765	-.2739	.1862
V105	-.2343	-.1074	.1743	.3039	1.0000	-.2045	-.2059	.0931	-.0081	.4690
V106	-.3192	-.4977	-.0059	-.4026	-.2045	1.0000	.7648	.4126	-.2097	-.2582
V107	-.2004	-.4311	-.0227	-.4676	-.2059	.7648	1.0000	-.1625	-.0090	-.1549
V108	-.3516	-.2711	-.0164	-.1765	.0931	.4126	-.1625	1.0000	-.2123	-.1069
V109	-.5746	-.3384	-.5137	-.2739	-.0081	-.2097	-.0090	-.2123	1.0000	.5518
V110	-.1922	-.0343	-.1290	.1862	.4690	-.2582	-.1549	-.1069	.5518	1.0000
V111	-.4820	-.4197	-.0835	-.3119	-.1515	.5542	.7010	-.1371	.4320	-.1305
V112	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V113	-.3387	-.5219	-.0168	-.4557	-.1987	.9879	.8459	.3357	-.1516	-.2406
V114	-.2191	-.2172	-.0040	-.2578	.2127	.0247	.4238	-.4911	.2076	.0948
V115	.1975	.2126	.3425	.0370	.1343	-.2518	.1374	-.3645	.0276	-.1090
V116	.4047	.4303	.1857	.2613	-.3570	-.3110	-.2212	-.3727	-.0259	-.3362
V117	.3009	.1610	.0001	.0060	.0822	-.5051	.0369	-.7552	.0369	.0310
V118	.3094	.3353	.0637	.4677	-.2180	-.0051	-.1821	-.1111	-.1888	-.1658
V119	.1037	.1049	.3591	-.0747	.2025	-.0879	-.0170	.2260	-.1646	-.0595
V120	0	-.0870	-.2245	-.2137	-.3790	-.1094	.1503	-.3426	.4639	.2236

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V101	V102	V103	V104	V105	V106	V107	V108	V109	V110
V121	.3607	.5837	.8149	.5260	.1337	-.0767	.0650	-.1433	-.1150	-.2139
V122	.0450	.0757	.2916	-.0804	.1671	-.1369	.1878	-.2436	.0706	-.0773
V123	.0932	.2020	-.0519	.1725	-.2070	-.3606	-.3461	-.1566	.0932	-.4089
V124	.5083	.2728	.2503	.1890	.0697	-.2406	-.2728	.0584	-.6871	-.5672
V125	.5107	.2643	.2557	.1358	-.0606	-.1526	-.2348	.1117	-.7274	-.6877
V126	-.4429	-.3852	-.0064	-.2677	-.1095	.6247	.7640	-.1279	.3166	-.1275
V127	-.2230	-.0520	-.1053	.1920	.4783	-.1972	-.0925	-.1128	.5604	.9948
V128	-.4555	-.3883	-.0263	-.2820	-.1245	.6123	.7559	-.1333	.3307	-.1327
V129	.1414	.0904	.2052	-.1497	.1773	-.0940	-.0192	.2313	-.4987	-.3063
V130	-.3427	-.3122	.1213	-.1637	-.0347	.6970	.8067	-.1033	.1399	-.1105
V131	-.3418	-.2970	.1046	-.1860	-.0749	.6658	.7783	-.0841	.1437	-.1397
V132	-.3945	-.2054	-.1109	.0616	.3947	.0631	.2200	-.1594	.6540	.8728
V133	-.2740	-.0967	-.0962	.1615	.4655	-.1081	.0132	-.1259	.5859	.9729
V134	-.2734	.0103	-.3265	-.0150	.1612	-.3605	-.2349	-.1491	.4580	.6650
V135	-.7157	-.5229	-.3341	-.3320	.0352	.2865	.2623	.1788	.8084	.3413
V136	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V137	-.4376	-.2739	-.4906	-.3194	-.3641	-.0765	-.3133	.3396	.5009	-.1717
V138	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V139	-.3549	-.5230	-.0230	-.5180	-.1447	.9143	.7556	.5148	-.1687	-.2170
V140	-.2518	-.0677	-.1877	.1497	.4336	-.2899	-.1791	-.1207	.6518	.9910
V141	-.5556	-.5148	-.2182	-.3299	.2080	.5007	.4518	.3338	.4712	.6201

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

V201	.6937	.9440	.8349	.8364	-.0199	-.4082	-.3552	-.1782	-.2188	-.0287
V202	-.0773	-.3722	-.4112	-.4816	.1283	-.0672	-.1237	.2401	-.4015	-.2313
V203	.6716	.9202	.7883	.7576	-.1160	-.4102	-.2983	-.2277	-.1588	-.0727
V204	-.5584	-.4294	-.3945	-.3105	.1936	-.0824	.1838	-.3261	.4013	-.1955
V205	.6670	.5270	.4871	.4882	.2136	-.2666	-.3285	-.0098	-.8093	-.3100
V206	.1996	.2752	.0489	.2158	.0963	-.2603	-.1536	-.0724	.1954	.7325
V207	.1643	.4553	.5812	.2691	-.1401	-.0575	.1452	-.2146	.0688	-.2195
V208	-.4901	-.2648	-.3280	-.1764	-.1239	.1212	.1165	.0139	.8055	.5996
V209	-.1328	-.1055	-.2490	.0691	.2398	-.1519	-.0811	-.0907	.5401	.9210
V210	-.2271	-.0952	-.2503	.0308	.1251	-.1059	-.0626	-.0296	.6710	.9182
V211	-.2693	.0234	.1856	-.0209	.1575	.1029	-.2783	.7627	-.1660	-.1019
V212	.0713	-.0411	-.1643	.0197	.0204	.0669	.2344	-.2556	.2121	.5586
V213	-.1405	-.1631	.1492	-.0419	-.1554	.7397	.7526	-.0879	-.1416	-.2094
V214	-.1627	.1157	.2428	.0216	.0806	.0875	-.2863	.7508	-.1760	-.0509
V215	.0425	-.0632	-.2250	.0302	.1611	-.1668	.0099	-.2668	.4155	.8606
V216	-.2955	-.0566	-.0763	-.0546	-.3735	.3078	.1224	.2176	.5274	.3134
V217	-.5752	-.4301	-.3055	-.4397	-.2991	.3430	.5198	-.1789	.5938	-.1668
V218	.2903	-.0802	-.2855	-.2478	-.5374	.1692	.2151	-.2239	-.1629	-.2024
V219	-.4883	-.4220	-.2128	-.1806	.0960	.4249	.5483	-.1900	.5905	.5270
V220	.5630	.5164	.2106	.5342	-.2767	-.1284	-.2360	-.1453	-.3085	-.1554

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 01/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V101	V102	V103	V104	V105	V106	V107	V108	V109	V110
V221	.5324	.5952	.3245	.5938	-.2807	-.0765	-.3315	.0817	-.3965	-.2190
V222	-.0097	.2367	.4377	.1617	.0599	.1245	-.2760	.7433	-.2981	-.1830
V223	.2010	-.0024	.1433	.2067	.6738	-.2347	-.1931	-.0521	-.4762	.0209
V224	-.0361	.2674	.3299	.1027	-.0328	.0153	-.3058	.6149	-.2492	-.2047
V225	.3210	.3354	.0737	.4336	-.2382	.0205	-.1625	-.1000	-.2123	-.1069
V226	-.0948	.1795	.2978	.0633	-.0007	.1034	-.2949	.7410	-.2636	-.1968
V227	-.1941	-.0499	.1151	.1546	.1299	.4648	.3461	.1551	.1756	.5943
V228	.0089	.0773	-.2314	.0395	-.4893	.0634	-.0877	.1278	.2356	.3277
V229	.1526	.3848	.1867	.2641	-.3385	-.4245	-.3832	-.0844	.5623	.3442
V230	.3374	.2606	.1676	-.0057	-.2161	-.1500	-.0920	.1798	-.1773	.0029
V231	.3865	.7144	.5978	.6705	.0328	-.2603	-.5407	.3676	-.3641	-.6060
V232	.7095	.8479	.9075	.7818	.0350	-.2590	-.3144	.0181	-.3964	-.3716
V233	.0633	.1946	.4969	.1412	.0980	.1347	-.0284	.4237	-.1490	-.3623
V234	.0118	.1226	.4682	.0631	.0514	.2263	.0832	.4051	-.0941	-.3028
V235	-.0905	-.3938	-.4291	-.2451	.0493	.1397	.2978	-.4325	-.0012	.2805
V236	.2193	.2547	-.0985	.2548	-.0093	-.2100	-.2378	-.2030	-.3748	-.2842
V237	-.0929	-.2617	-.3659	-.1231	.1919	-.0524	.3173	-.4018	-.0206	.2444
V238	-.0810	.0065	-.2191	-.3843	-.6125	-.0489	.3294	-.3581	.3864	-.2540
V239	-.6807	-.6564	-.5633	-.5193	.2012	.0605	.2816	-.2277	.3831	-.1726
V240	.3421	.0500	.0772	.0586	.2751	-.0846	-.1526	.0781	-.7453	-.2841
V241	.3056	.2380	.3965	.5173	.4320	.0207	-.3857	.3921	-.4457	.2751

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V111	V112	V113	V114	V115	V116	V117	V118	V119	V120
V101	-.4820	99.0000	-.3387	-.2191	.1975	.4047	.3009	.3094	.1037	0
V102	-.4197	99.0000	-.5219	-.2172	.2126	.4303	.1610	.3353	.1049	-.0870
V103	-.0835	99.0000	-.0168	-.0040	.3425	.1857	.0001	.0637	.3591	-.2245
V104	-.3119	99.0000	-.4557	-.2578	.0370	.2613	.0060	.4677	-.0747	-.2137
V105	-.1515	99.0000	-.1987	.2127	.1343	-.3570	.0822	-.2180	.2025	-.3790
V106	.5542	99.0000	.9879	.0247	-.2518	-.3110	-.5051	-.0051	-.0879	-.1094
V107	.7010	99.0000	.8459	.4238	.1374	-.2212	.0369	-.1821	-.0170	.1503
V108	-.1371	99.0000	.3357	-.4911	-.3645	-.3727	-.7552	-.1111	.2260	-.3426
V109	.4320	99.0000	-.1516	.2076	.0276	-.0259	.0369	-.1888	-.1646	.4639
V110	-.1305	99.0000	-.2406	.0948	-.1090	-.3362	.0310	-.1658	-.0595	.2236
V111	1.0000	99.0000	.6209	.3355	.1242	-.1336	-.0500	-.1530	-.1434	.3817
V112	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V113	.6209	99.0000	1.0000	.1112	-.1607	-.3316	-.4169	-.0845	-.0413	-.0496
V114	.3355	99.0000	.1112	1.0000	.5386	.1509	.4797	-.4911	.2689	-.0654
V115	.1242	99.0000	-.1607	.5386	1.0000	.5626	.7544	-.7645	.7787	.4820
V116	-.1336	99.0000	-.3316	.1509	.5626	1.0000	.5415	-.1899	.2948	.4907
V117	-.0500	99.0000	-.4169	.4797	.7544	.5415	1.0000	-.4198	.3071	.5478
V118	-.1530	99.0000	-.0845	-.4911	-.7645	-.1899	-.4198	1.0000	-.8583	-.3426
V119	-.1434	99.0000	-.0413	.2689	.7787	.2948	.3071	-.8583	1.0000	.1665
V120	.3817	99.0000	-.0496	-.0654	.4820	.4907	.5478	-.3426	.1665	1.0000

BIVARIATE CORRELATION MATRIC OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

- - - - - - - - - - - - PEARSON CORRELATION COEFFICIENTS - - - - - - - - - - - -

	V111	V112	V113	V114	V115	V116	V117	V118	V119	V120
V121	.1238	99.0000	-.0421	.3960	.4463	.1526	.0167	-.1433	.4199	-.2676
V122	.1732	99.0000	-.0509	.6375	.9712	.4987	.6420	-.8536	.8329	.3748
V123	.1570	99.0000	-.3674	-.3949	.0831	.2453	.2773	.1370	-.2062	.6118
V124	-.4475	99.0000	-.2597	-.4125	.0015	-.1838	.2394	.0983	.1063	-.0786
V125	-.4188	99.0000	-.1811	-.4424	-.0750	-.2079	.1429	.1470	.0989	-.1766
V126	.9803	99.0000	.6889	.3593	.1551	-.1044	-.0385	-.1425	-.1216	.3261
V127	-.0479	99.0000	-.1771	.3280	.1213	-.1169	-.0600	-.0897	-.1582	.3065
V128	.9804	99.0000	.6773	.3677	.1601	-.0913	-.0299	-.1487	-.1235	.3339
V129	-.4228	99.0000	-.0563	.2175	.2082	-.3386	.0530	-.3585	.5038	-.5259
V130	.9064	99.0000	.7512	.3350	.1470	-.1006	-.0548	-.0809	-.1143	.2235
V131	.9007	99.0000	.7232	.2931	.2133	-.0358	-.0045	-.1400	-.0562	.3201
V132	.3495	99.0000	.1084	.3724	.1654	-.0829	-.0255	-.1488	-.1208	.3278
V133	.0778	99.0000	-.0799	-.3321	.1657	-.0882	-.0349	-.1235	-.1106	.3100
V134	-.2044	99.0000	-.3429	.2047	.1625	.3822	.2333	-.1111	.0100	.0420
V135	.7165	99.0000	.3255	.0522	-.0967	-.2909	-.3412	-.2073	-.0839	.3248
V136	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V137	.1669	99.0000	-.1072	-.3487	-.4723	-.2601	-.4780	.1328	-.2919	.0890
V138	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V139	.4908	99.0000	.9381	-.0232	-.1255	-.4633	-.4596	-.2219	.1418	-.0608
V140	-.0718	99.0000	-.2691	.0675	-.0535	-.0685	-.0009	-.1378	-.1511	.4116
V141	.3955	99.0000	.5373	-.0215	-.1609	-.4908	-.4971	-.2500	.0862	.0485

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

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81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V111	V112	V113	V114	V115	V116	V117	V118	V119	V120
V201	-.2122	99.0000	-.4105	-.1373	.2563	.3051	.0436	.2355	.1857	-.1179
V202	-.5561	99.0000	-.0770	.0122	-.1345	-.2962	.1001	-.2342	.1493	-.3038
V203	-.1397	99.0000	-.4042	-.1037	.3187	.3373	.1025	.1833	.2055	-.0207
V204	.5531	99.0000	-.0126	.4402	.0751	-.2642	.2783	-.1315	-.2882	.1813
V205	-.6850	99.0000	-.3126	-.1695	-.1349	-.1353	.0388	.3483	-.0064	-.5996
V206	-.3315	99.0000	-.2449	-.3372	.3679	.5291	.2934	-.1348	.3760	.4003
V207	.3534	99.0000	-.0029	.4904	.5384	.2730	.1255	-.2429	.3752	-.0285
V208	.4525	99.0000	.1375	.0189	.0592	.2946	-.1622	-.1718	-.0428	.5479
V209	-.0858	99.0000	-.1419	-.5152	-.1445	.1595	.0480	.0787	-.1596	.6771
V210	.0057	99.0000	-.0944	-.3498	-.3106	.0304	-.3741	.1480	-.2168	.3790
V211	-.2199	99.0000	.0599	-.0733	-.0609	-.2031	-.5478	-.2465	.4179	-.5493
V212	-.0892	99.0000	.0882	-.0649	-.5713	-.4864	-.2598	.5933	-.5884	-.3538
V213	.6800	99.0000	.7551	.1443	-.1515	-.1437	-.1999	.2994	-.3969	-.0159
V214	-.2744	99.0000	.0435	-.1221	-.0156	-.1088	-.5304	-.2485	.4769	-.4969
V215	-.1876	99.0000	-.1465	-.0996	-.0210	.2067	.2939	.0669	-.0971	.3891
V216	.4318	99.0000	.2871	-.1629	-.0319	.3349	-.3772	-.0064	-.0071	.3466
V217	.9185	99.0000	.4126	.3628	.1371	-.0222	.0248	-.2010	-.1616	.4526
V218	-.1640	99.0000	.1509	-.1277	-.5471	-.2022	-.1463	.5167	-.5345	-.1711
V219	.6953	99.0000	.4667	.3272	.0852	.0663	-.0094	-.1008	-.2005	.4087
V220	-.1991	99.0000	-.1886	-.7175	-.4478	.0488	-.1205	.8184	-.5997	.0890

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

V221	-.2807	99.0000	-.1615	-.7452	-.5563	-.0209	-.3788	.8679	-.5553	-.1941
V222	-.2346	99.0000	.0721	-.1708	-.0032	-.1056	-.5624	-.1921	.4935	-.5067
V223	-.4924	99.0000	-.2444	.0930	-.0806	-.3872	.1673	.0450	.0134	-.4838
V224	-.2624	99.0000	-.0269	-.0608	.0805	.0494	-.4164	-.2156	.4721	-.4583
V225	-.1371	99.0000	-.0576	-.4911	-.7645	-.1899	-.4198	1.0000	-.8583	-.3426
V226	-.2523	99.0000	.0509	-.1593	-.0086	-.0454	-.5246	-.2070	.4583	-.4715
V227	.2460	99.0000	.4509	-.0950	-.2597	-.0733	-.5062	.3036	-.2270	-.1901
V228	.0322	99.0000	.0296	-.6399	-.7822	-.4246	-.5819	.7532	-.7132	-.1119
V229	.1368	99.0000	-.4151	-.1518	.1623	.2446	-.0347	-.0400	.1426	.3365
V230	-.2316	99.0000	-.1166	-.4341	.4422	.2751	.2646	-.3781	.5657	.5399
V231	-.3685	99.0000	-.3233	-.4829	.0732	.2725	-.2373	.1662	.2415	-.1538
V232	-.2789	99.0000	-.2859	-.1168	.3400	.3565	-.0143	.0320	.4343	-.1438
V233	.0675	99.0000	.1343	-.0308	.6156	.3856	.0250	-.6236	.8292	.2591
V234	.1609	99.0000	.2338	.0451	.6220	.3698	.0102	-.6553	.8271	.2697
V235	.0543	99.0000	.1415	.2601	-.4449	-.3152	.0808	.4008	-.6524	-.2188
V236	-.4652	99.0000	-.2620	-.0947	-.5029	-.0818	-.0883	.6915	-.6162	-.5463
V237	-.0102	99.0000	-.0173	.1139	-.5031	-.5532	.0488	.5080	-.7164	-.3155
V238	.4554	99.0000	.0507	.2046	.3527	.1955	.3386	-.2232	.0467	.5697
V239	.5330	99.0000	.1259	.4610	.0015	-.3438	.2291	-.2071	-.2766	.1502
V240	-.6402	99.0000	-.1210	-.0708	-.2416	-.3237	.0513	.1843	-.0552	-.5743
V241	-.5552	99.0000	-.0876	-.3471	-.2771	-.0057	-.3717	.2481	.0819	-.5094

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V121	V122	V123	V124	V125	V126	V127	V128	V129	V130
V101	.3607	.0450	.0932	.5083	.5107	-.4429	-.2230	-.4555	.1414	-.3427
V102	.5837	.0757	.2020	.2728	.2643	-.3852	-.0520	-.3883	.0904	-.3122
V103	.8149	.2916	-.0519	.2503	.2557	-.0064	-.1053	-.0263	.2052	.1213
V104	.5260	-.0804	.1725	.1890	.1358	-.2677	.1920	-.2820	-.1497	-.1637
V105	.1337	.1671	-.2070	.0697	-.0606	-.1095	.4783	-.1245	.1773	-.0347
V106	-.0767	-.1369	-.3606	-.2406	-.1526	.6247	-.1972	.6123	-.0940	.6970
V107	.0650	.1878	-.3461	-.2728	-.2348	.7640	-.0925	.7559	-.0192	.8067
V108	-.1433	-.2436	-.1566	.0584	.1117	-.1279	-.1128	-.1333	.2313	-.1033
V109	-.1150	.0706	.0932	-.6871	-.7274	.3166	.5604	.3307	-.4987	.1399
V110	-.2139	-.0773	-.4089	-.5672	-.6877	-.1275	.9948	-.1327	-.3063	-.1105
V111	.1238	.1732	.1570	-.4475	-.4188	.9803	-.0479	.9804	-.4228	.9064
V112	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V113	-.0421	-.0509	-.3674	-.2597	-.1811	.6889	-.1771	.6773	-.0563	.7512
V114	.3960	.6375	-.3949	-.4125	-.4424	.3593	.3280	.3677	.2175	.3350
V115	.4463	.9712	.0831	.0015	-.0750	.1551	.1213	.1601	.2082	.1470
V116	.1526	.4987	.2453	-.1838	-.2079	-.1044	-.1169	-.0913	-.3386	-.1006
V117	.0167	.6420	.2773	.2394	.1429	-.0385	-.0600	-.0299	.0530	-.0548
V118	-.1433	-.8536	.1370	.0983	.1470	-.1425	-.0897	-.1487	-.3585	-.0809
V119	.4199	.8329	-.2062	.1063	.0989	-.1216	-.1582	-.1235	.5038	-.1143
V120	-.2676	.3748	.6118	-.0786	-.1766	.3261	.3065	.3339	-.5259	.2235

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

- - - - - - - - - - - - PEARSON CORRELATION COEFFICIENTS - - - - - - - - - - -

	V121	V122	V123	V124	V125	V126	V127	V128	V129	V130
V121	1.0000	.4768	-.2376	-.1687	-.1352	.1534	.1537	.1459	.2614	.1893
V122	.4768	1.0000	-.0692	-.1314	-.1912	.2008	.1603	.2063	.2564	.1831
V123	-.2376	-.0692	1.0000	.4099	.3764	.0806	-.4032	.0913	-.3112	-.0237
V124	-.1687	-.1314	.4099	1.0000	.9797	-.4504	-.6086	-.4613	.4668	-.4045
V125	-.1352	-.1912	.3764	.9797	1.0000	-.4275	-.7295	-.4371	.4900	-.3905
V126	.1534	.2008	.0806	-.4504	-.4275	1.0000	-.0363	.9992	-.3747	.9700
V127	.1537	.1603	-.4032	-.6086	-.7295	-.0363	1.0000	-.0420	-.3469	-.0134
V128	.1459	.2063	.0913	-.4613	-.4371	.9992	-.0420	1.0000	-.3721	.9648
V129	.2614	.2564	-.3112	.4668	.4900	-.3747	-.3469	-.3721	1.0000	-.3187
V130	.1893	.1831	-.0237	-.4045	-.3905	.9700	-.0134	.9648	-.3187	1.0000
V131	.1548	.2359	.0607	-.3780	-.3711	.9655	-.0429	.9633	-.3123	.9890
V132	.1470	.2112	-.3413	-.7573	-.8603	.3698	.9146	.3653	-.4681	.3782
V133	.1594	.2017	-.3943	-.6616	-.7803	.0961	.9910	.0903	-.3890	.1197
V134	-.1433	.1630	-.2258	-.5857	-.6641	-.1583	.6594	-.1349	-.0862	-.1540
V135	-.0373	-.0007	.0489	-.6347	-.6384	.6228	.3835	.6235	-.5026	.4820
V136	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V137	-.2822	-.4138	.4071	-.1088	-.0308	.0079	-.1967	.0221	-.2325	-.1900
V138	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V139	-.0643	-.0183	-.3676	-.1353	-.0735	.5487	-.1709	.5373	.1566	.6023
V140	-.1417	-.0204	-.3372	-.6027	-.7187	-.0914	.9856	-.0943	-.3626	-.1056
V141	-.1038	-.0401	-.5183	-.6355	-.6742	.4099	.6543	.4000	-.2146	.4181

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V121	V122	V123	V124	V125	V126	V127	V128	V129	V130
V201	.7662	.1574	.1959	.1723	.1738	-.1951	-.0306	-.2008	.0895	-.1480
V202	-.5174	-.0887	-.2244	.5087	.5109	-.5481	-.2941	-.5448	.6391	-.5256
V203	.7620	.2127	.2523	.1466	.1520	-.1291	-.0725	-.1307	.0930	-.1021
V204	-.1581	.0831	.4283	-.0392	-.0720	.5026	-.1605	.5178	-.0687	.3881
V205	.1876	-.2078	-.0705	.7551	.7569	-.6248	-.3539	-.6382	.5759	-.4900
V206	-.0524	.2486	-.2455	-.3167	-.4291	-.2715	.7197	-.2703	-.1417	-.2004
V207	.9004	.5670	.0440	-.2240	-.1601	.3644	-.1839	.3726	.1825	.3347
V208	-.0873	.1184	-.0655	-.8680	-.8914	.4138	.6348	.4236	-.6689	.3249
V209	-.6154	-.2296	-.2703	-.4966	-.6145	-.0976	.9142	-.1046	-.4853	-.0928
V210	-.2340	-.2908	-.3488	-.6855	-.7605	-.0232	.9138	-.0254	-.4707	-.0498
V211	.3120	.0789	-.2526	-.0663	.0016	-.1922	-.1119	-.1842	.5348	-.1765
V212	-.1141	-.5920	-.5473	-.3012	-.3263	-.0835	.5430	-.0949	-.1212	-.0359
V213	.0787	-.1476	-.0841	-.2705	-.2347	.7859	-.1217	.7805	-.2622	.8831
V214	.3509	.1113	-.2928	-.0944	-.0256	-.2424	-.0653	-.2353	.5138	-.2182
V215	-.3922	-.0878	-.4251	-.4248	-.5239	-.1926	.8404	-.2017	-.3708	-.1710
V216	.0949	.0246	.0339	-.7772	-.7341	.4177	.3552	.4261	-.6120	.3632
V217	.0233	.1882	.2894	-.5008	-.4596	.8667	-.1021	.8817	-.3916	.7311
V218	-.3276	-.5636	-.2239	.1439	.2318	-.2034	-.2423	-.2090	-.0375	-.2085
V219	-.0554	.1373	-.2242	-.7935	-.8384	.7195	.5980	.7166	-.6537	.7121
V220	-.2094	-.6348	.4853	.4073	.3853	-.1857	-.1589	-.1936	-.3372	-.1206

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

V221	-.0386	-.6941	.3646	.3594	.3812	-.2562	-.2254	-.2619	-.1776	-.1788
V222	.4836	.1110	-.2106	.0382	.1215	-.2093	-.1927	-.2093	.4893	-.1768
V223	-.0663	-.0964	-.2048	.6025	.5309	-.4625	-.0147	-.4817	.4678	-.3660
V224	.4464	.1831	-.1616	-.0366	.0461	-.2218	-.2150	-.2098	.5228	-.1977
V225	-.1433	-.8536	.1652	.1371	.1750	-.1279	-.1078	-.1333	-.3084	-.0697
V226	.3672	.1055	-.1765	-.0126	.0699	-.2168	-.2069	-.2087	.4974	-.1902
V227	.1374	-.2140	-.5156	-.6845	-.7113	.3498	.6484	.3420	-.3539	.4671
V228	-.2719	-.8415	.2133	-.0446	.0055	-.0315	-.0022	-.0300	-.2839	-.0790
V229	.3906	.1358	.4852	-.1416	-.1129	-.0083	-.0252	-.0040	-.3131	-.1750
V230	-.0786	.3316	.2709	.3781	.3377	-.2130	-.2225	-.2129	.1922	-.1942
V231	.3907	.0088	.2588	.1913	.2060	-.3100	-.2959	-.3072	.1448	-.2323
V232	.7921	.2922	-.0059	.2067	.2593	-.2530	-.2375	-.2668	.1461	-.1829
V233	.4283	.6533	.0088	-.0687	-.0856	.1092	.0897	.1050	.1225	.1385
V234	.4464	.6784	-.0653	-.1697	-.1831	.2004	.1790	.1959	.0939	.2227
V235	-.4072	-.4364	-.2542	.0257	.0393	.0424	.0617	.0354	-.1669	.0540
V236	-.1912	-.5584	-.1278	.1449	.1723	-.3884	-.3586	-.3784	.1593	-.2859
V237	-.3788	-.5536	-.0680	.2797	.2798	-.0215	.0883	-.0306	.0651	.5080
V238	.0528	.2969	.3594	-.1886	-.1599	.4163	-.2383	.4415	-.0023	.2951
V239	-.3337	.0464	.2716	-.0676	-.0933	.4861	-.1428	.4997	-.0405	.3775
V240	-.2131	-.2616	-.2198	.7185	.7126	-.5831	-.3325	-.5947	.6136	-.4620
V241	.0929	-.2455	-.3793	.1629	.1491	-.5069	.2533	-.5324	-.0085	-.3699

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 10.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V131	V132	V133	V134	V135	V136	V137	V138	V139	V140
V101	-.3418	-.3945	-.2740	-.2734	-.7157	99.0000	-.4376	99.0000	-.3549	-.2518
V102	-.2970	-.2054	-.0967	.0103	-.5229	99.0000	-.2739	99.0000	-.5230	-.0677
V103	.1046	-.1109	-.0962	-.3265	-.3341	99.0000	-.4906	99.0000	-.0230	-.1877
V104	-.1860	.0616	.1615	-.0150	-.3320	99.0000	-.3194	99.0000	-.5180	.1497
V105	-.0749	.3947	.4655	.1612	.0352	99.0000	-.3641	99.0000	-.1447	.4336
V106	.6658	.0631	-.1081	-.3605	.2865	99.0000	-.0765	99.0000	.9143	-.2899
V107	.7783	.2200	.0132	-.2349	.2623	99.0000	-.3133	99.0000	.7556	-.1791
V108	-.0841	-.1594	-.1259	-.1491	.1788	99.0000	.3396	99.0000	.5148	-.1207
V109	.1437	.6540	.5859	.4580	.8084	99.0000	.5009	99.0000	-.1687	.6518
V110	-.1397	.8728	.9729	.6650	.3413	99.0000	-.1717	99.0000	-.2170	.9910
V111	.9007	.3495	.0778	-.2044	.7165	99.0000	.1669	99.0000	.4908	-.0718
V112	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V113	.7232	.1084	-.0799	-.3429	.3255	99.0000	-.1072	99.0000	.9381	-.2691
V114	.2931	.3724	.3321	.2047	.0522	99.0000	-.3487	99.0000	-.0232	.0675
V115	.2133	.1654	.1657	.1625	-.0967	99.0000	-.4723	99.0000	-.1255	-.0535
V116	-.0358	-.0829	-.0882	.3822	-.2909	99.0000	-.2601	99.0000	-.4633	-.0685
V117	-.0045	-.0255	-.0349	.2333	-.3412	99.0000	-.4780	99.0000	-.4596	-.0009
V118	-.1400	-.1488	-.1235	-.1111	-.2073	99.0000	.1328	99.0000	-.2219	-.1378
V119	-.0562	-.1208	-.1106	.0100	-.0839	99.0000	-.2919	99.0000	.1418	-.1511
V120	.3201	.3278	.3100	.0420	.3248	99.0000	.0890	99.0000	-.0608	.4116

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 01/02/23. 10.31.42.

FILE FUEL (CREATION DATE = 01/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V131	V132	V133	V134	V135	V136	V137	V138	V139	V140
V121	.1548	.1470	.1594	-.1433	-.0373	99.0000	-.2822	99.0000	-.0643	-.1417
V122	.2359	.2112	.2017	.1630	-.0007	99.0000	-.4138	99.0000	-.0183	-.0204
V123	.0607	-.3413	-.3943	-.2258	.0489	99.0000	.4071	99.0000	-.3676	-.3372
V124	-.3780	-.7573	-.6616	-.5857	-.6347	99.0000	-.1088	99.0000	-.1353	-.6027
V125	-.3711	-.8603	-.7003	-.6641	-.6384	99.0000	-.0308	99.0000	-.0735	-.7187
V126	.9655	.3698	.0961	-.1503	.6228	99.0000	.0079	99.0000	.5487	-.0914
V127	-.0429	.9146	.9910	.6594	.3835	99.0000	-.1967	99.0000	-.1709	.9856
V128	.9633	.3653	.0903	-.1349	.6235	99.0000	.0221	99.0000	.5373	-.0943
V129	-.3123	-.4681	-.3890	-.0862	-.5026	99.0000	-.2325	99.0000	.1566	-.3626
V130	.9890	.3782	.1197	-.1540	.4820	99.0000	-.1900	99.0000	.6023	-.1056
V131	1.0000	.3513	.0909	-.1185	.4744	99.0000	-.1750	99.0000	.5967	-.1318
V132	.3513	1.0000	.9598	.5708	.6042	99.0000	-.1798	99.0000	.0578	.8792
V133	.0909	.9598	1.0000	.6399	.4530	99.0000	-.2115	99.0000	-.0914	.9661
V134	-.1185	.5708	.6399	1.0000	.0727	99.0000	-.1188	99.0000	-.3286	.6615
V135	.4744	.6042	.4530	.0727	1.0000	99.0000	.5313	99.0000	.3204	.4298
V136	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V137	-.1750	-.1798	-.2115	-.1188	.5313	99.0000	1.0000	99.0000	-.0470	-.0617
V138	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V139	.5967	.0578	-.0914	-.3286	.3204	99.0000	-.0470	99.0000	1.0000	-.2490
V140	-.1318	.8792	.9661	.6615	.4298	99.0000	-.0617	99.0000	-.2490	1.0000
V141	.3945	.7698	.7063	.2663	.6924	99.0000	.0102	99.0000	.6024	.6156

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V131	V132	V133	V134	V135	V136	V137	V138	V139	V140
V201	-.1422	-.1113	-.0526	-.0736	-.2903	99.0000	-.1753	99.0000	-.4067	-.0439
V202	-.5220	-.4909	-.3639	-.0659	-.4831	99.0000	-.0569	99.0000	.0694	-.2726
V203	-.0824	-.1211	-.0859	-.0501	-.2520	99.0000	-.1363	99.0000	-.3852	-.0783
V204	.3938	.0611	-.1008	.0104	.3574	99.0000	.2584	99.0000	-.0809	-.1234
V205	-.5259	-.5888	-.4279	-.3263	-.8542	99.0000	-.3892	99.0000	-.2628	-.3916
V206	-.1513	.5662	.6904	.6795	-.0444	99.0000	-.3761	99.0000	-.1516	.6874
V207	.3422	-.0173	-.1350	-.0240	.0880	99.0000	-.0663	99.0000	-.0433	-.1951
V208	.3472	.7637	.6820	.5314	.7669	99.0000	.2790	99.0000	.0797	.6597
V209	-.0993	.8072	.8967	.5469	.3684	99.0000	-.0999	99.0000	-.1194	.9175
V210	-.0678	.8392	.9030	.5985	.5074	99.0000	.0700	99.0000	-.0766	.9329
V211	-.1589	-.1731	-.1334	.1304	.0194	99.0000	.2200	99.0000	.2322	-.1132
V212	-.1264	.4632	.5267	.2150	.0709	99.0000	-.1340	99.0000	.0513	.5257
V213	.8573	.2040	-.0084	-.1519	.1706	99.0000	-.2762	99.0000	.5740	-.2398
V214	-.1945	-.1503	-.0926	.1628	-.0136	99.0000	.1764	99.0000	.2247	-.0689
V215	-.1999	.6991	.8102	.4773	.1709	99.0000	-.2490	99.0000	-.1547	.8398
V216	.3933	.5045	.4074	.3334	.6298	99.0000	.3137	99.0000	.2216	.3594
V217	.7526	.2622	.0056	-.0048	.7167	99.0000	.3835	99.0000	.3033	-.0785
V218	-.2760	-.3160	-.2753	-.3084	-.2535	99.0000	.1235	99.0000	.0661	-.2141
V219	.6901	.8470	.6904	.3212	.6886	99.0000	-.1190	99.0000	.3098	.5479
V220	-.1091	-.2315	-.1784	-.2166	-.3306	99.0000	.0192	99.0000	-.2436	-.1753

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

V221	-.1772	-.3197	-.2535	-.1996	-.3602	99.0000	.1049	99.0000	-.1920	-.2444
V222	-.1629	-.2614	-.2155	-.0747	-.0517	99.0000	.1619	99.0000	.2339	-.2019
V223	-.4293	-.2119	-.0736	-.2475	-.5026	99.0000	-.4075	99.0000	-.1935	-.0426
V224	-.1619	-.2778	-.2379	.1487	-.1377	99.0000	.1408	99.0000	.1170	-.2198
V225	-.1249	-.1594	-.1250	-.1491	-.2276	99.0000	.1490	99.0000	-.1933	-.1207
V226	-.1577	-.2713	-.2294	.0769	-.0771	99.0000	.1896	99.0000	.2125	-.2131
V227	.4345	.7451	.7011	.4355	.3195	99.0000	-.3004	99.0000	.3755	.5465
V228	-.0981	-.0380	-.0484	-.0819	.2227	99.0000	.5743	99.0000	.0523	.2895
V229	-.1523	-.0222	-.0762	-.1733	.4159	99.0000	.5881	99.0000	-.3803	.6860
V230	-.0778	-.2097	-.1716	.0630	-.1632	99.0000	-.1477	99.0000	.1203	-.1508
V231	-.1712	-.2973	-.2553	.2166	-.2866	99.0000	-.0411	99.0000	-.2108	-.3417
V232	-.1849	-.2669	-.2242	-.2528	-.3134	99.0000	-.2677	99.0000	-.2527	-.2992
V233	.2136	.1090	.1399	-.0333	.1174	99.0000	-.1811	99.0000	.2574	-.1850
V234	.2895	.1991	.2256	-.0571	.1915	99.0000	-.1774	99.0000	.3371	-.1490
V235	-.0444	.0314	.0196	-.1954	-.1123	99.0000	-.0945	99.0000	-.0471	.0161
V236	-.3249	-.3636	-.3501	.4335	-.6130	99.0000	-.1782	99.0000	-.3528	-.3963
V237	-.4356	-.0366	-.0888	-.0678	-.1960	99.0000	-.0622	99.0000	-.1185	-.0184
V238	.3729	-.0384	-.1848	.1629	.2312	99.0000	.2491	99.0000	.0789	-.1934
V239	.3744	.0705	-.0855	.0015	.3763	99.0000	.2488	99.0000	.0648	-.1093
V240	-.5033	-.5503	-.4024	-.2898	-.7666	99.0000	-.3584	99.0000	-.0589	-.3667
V241	-.4302	.0160	.1901	-.1319	-.3067	99.0000	-.2854	99.0000	-.0916	.2046

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

81/02/23. 18.31.42.

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FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V141	V201	V202	V203	V204	V205	V206	V207	V208	V209
V101	-.5556	.6937	-.0773	.6716	-.5584	.6670	.1996	.1643	-.4901	-.1328
V102	-.5148	.9440	-.3722	.9282	-.4294	.5270	.2752	.4553	-.2648	-.1055
V103	-.2182	.8349	-.4112	.7883	-.3945	.4871	.0489	.5812	-.3280	-.2490
V104	-.3299	.8364	-.4816	.7576	-.3105	.4882	.2158	.2691	-.1764	.0691
V105	.2080	-.0199	.1283	-.1160	.1936	.2136	.0963	-.1401	-.1239	.2398
V106	.5007	-.4082	-.0672	-.4102	-.0024	-.2666	-.2603	-.0575	.1212	-.1519
V107	.4518	-.3552	-.1237	-.2983	.1838	-.3285	-.1536	.1452	.1165	-.0811
V108	.3338	-.1782	.2401	-.2277	-.3261	-.0098	-.0724	-.2146	.0139	-.0907
V109	.4712	-.2188	-.4015	-.1588	.4013	-.8093	.1954	.0688	.8055	.5401
V110	.6201	-.0287	-.2313	-.0727	-.1955	-.3100	.7325	-.2195	.5996	.9210
V111	.3955	-.2122	-.5561	-.1397	.5531	-.6850	-.3315	.3534	.4525	-.0858
V112	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V113	.5373	-.4185	-.0770	-.4042	-.0126	-.3126	-.2449	-.0029	.1375	-.1419
V114	-.0215	-.1373	.0122	-.1037	.4402	-.1695	-.3372	.4904	.0189	-.5152
V115	-.1609	.2563	-.1345	.3187	.0751	-.1349	.3679	.5384	.0592	-.1445
V116	-.4908	.3051	-.2962	.3373	-.2642	-.1353	.5291	.2730	.2946	.1595
V117	-.4971	.0436	.1001	.1025	.2783	.0388	.2934	.1255	-.1622	.0480
V118	-.2500	.2355	-.2342	.1833	-.1315	.3483	-.1348	-.2429	-.1718	.0787
V119	.0862	.1857	.1493	.2055	-.2882	-.0064	.3760	.3752	-.0428	-.1596
V120	.0485	-.1179	-.3038	-.0207	.1813	-.5996	.4003	-.0285	.5479	.6771

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V141	V201	V202	V203	V204	V205	V206	V207	V208	V209
V121	-.1038	.7662	-.5174	.7620	-.1501	.1876	-.0524	.9004	-.0873	-.6154
V122	-.0401	.1574	-.0887	.2127	.0831	-.2078	.2486	.5670	.1184	-.2296
V123	-.5183	.1959	-.2244	.2523	.4283	-.0705	-.2455	.0440	-.0655	-.2703
V124	-.6355	.1723	.5087	.1466	-.0392	.7551	-.3167	-.2240	-.8680	-.4966
V125	-.6742	.1738	.5109	.1520	-.0720	.7569	-.4291	-.1601	-.8914	-.6145
V126	.4099	-.1951	-.5481	-.1291	.5026	-.6248	-.2715	.3644	.4138	-.0976
V127	.6543	-.0306	-.2941	-.0725	-.1605	-.3539	.7197	-.1839	.6348	.9142
V128	.4000	-.2008	-.5448	-.1307	.5178	-.6382	-.2703	.3726	.4236	-.1046
V129	-.2146	.0895	.6391	.0930	-.0687	.5759	-.1417	.1825	-.6689	-.4853
V130	.4181	-.1480	-.5256	-.1021	.3881	-.4900	-.2004	.3347	.3249	-.0928
V131	.3945	-.1422	-.5220	-.0824	.3938	-.5259	-.1513	.3422	.3472	-.0993
V132	.7698	-.1113	-.4909	-.1211	.0611	-.5888	.5662	-.0173	.7637	.8072
V133	.7063	-.0526	-.3639	-.0859	-.1008	-.4279	.6904	-.1350	.6820	.8967
V134	.2663	-.0736	-.0659	-.0501	.0104	-.3263	.6795	-.0240	.5314	.5469
V135	.6924	-.2903	-.4831	-.2520	.3574	-.8542	-.0444	.0880	.7669	.3684
V136	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V137	.0102	-.1753	-.0569	-.1363	.2584	-.3892	-.3761	-.0663	.2790	-.0999
V138	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V139	.6024	-.4067	.0694	-.3852	-.0009	-.2628	-.1516	-.0433	.0797	-.1194
V140	.6156	-.0439	-.2726	-.0783	-.1234	-.3916	.6874	-.1951	.6597	.9175
V141	1.0000	-.3819	-.2036	-.3857	-.1096	-.6029	.3943	-.1755	.6555	.6430

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

81/02/23. 18.31.42.

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FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V141	V201	V202	V203	V204	V205	V206	V207	V208	V209
V201	-.3819	1.0000	-.5285	.9871	-.3219	.4030	.1611	.6421	-.1756	-.1532
V202	-.2036	-.5285	1.0000	-.5523	-.0287	.4373	-.1590	-.5493	-.5771	-.2217
V203	-.3057	.9871	-.5523	1.0000	-.2597	.3230	.1631	.7017	-.1333	-.1803
V204	-.1096	-.3219	-.0287	-.2597	1.0000	-.3040	-.5194	.1378	.0156	-.2915
V205	-.6029	.4030	.4373	.3230	-.3040	1.0000	-.1659	-.0772	-.9000	-.4118
V206	.3943	.1611	-.1590	.1631	-.5194	-.1659	1.0000	-.1594	.4611	.7862
V207	-.1755	.6421	-.5493	.7017	.1378	-.0772	-.1594	1.0000	.0548	-.4177
V208	.6555	-.1756	-.5771	-.1333	.0156	-.9000	.4611	.0548	1.0000	.6651
V209	.6430	-.1532	-.2217	-.1803	-.2915	-.4118	.7862	-.4177	.6651	1.0000
V210	.7091	-.0853	-.3418	-.0988	-.2779	-.5182	.7199	-.2267	.7815	.9443
V211	.1064	.1535	.1615	.1290	-.1940	.1033	-.0730	.2964	-.0602	-.3007
V212	.4413	-.1057	-.0276	-.1373	-.2155	.0425	.3141	-.3150	.1471	.5514
V213	.2608	-.1019	-.4091	-.0792	.2218	-.2010	-.1993	.1798	.1119	-.1748
V214	.1296	.2270	.1164	.2055	-.3422	.0989	.0556	.3133	-.0112	-.2229
V215	.5302	-.1637	-.0840	-.1928	-.3722	-.2563	.7488	-.4217	.5011	.9386
V216	.5222	.0406	-.6723	.0804	-.2144	-.7642	.3542	.2225	.8835	.4069
V217	.2590	-.2544	-.4787	-.1481	.6703	-.7794	-.3290	.3865	.5232	-.1330
V218	-.1362	-.2392	.2985	-.2419	-.2254	.2395	-.2122	-.3799	-.2602	-.0452
V219	.7191	-.3248	-.5516	-.3044	.2040	-.7733	.2765	.0072	.7921	.5693
V220	-.3544	.3738	-.2356	.3531	-.2116	.3728	.0784	-.2553	-.2254	.0178

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

V221	-.3659	.4940	-.2340	.4591	-.3118	.4613	.0017	-.1052	-.2722	-.1295
V222	.0280	.3755	.0244	.3425	-.3077	.2068	-.0700	.3964	-.1270	-.3405
V223	-.2508	-.0603	.5948	-.1694	.0336	.7318	-.1909	-.3702	-.7218	-.1114
V224	-.0811	.3598	.0504	.3561	-.2862	.1608	-.0088	.4670	-.0893	-.3850
V225	-.2579	.2357	-.2022	.1882	-.1077	.3607	-.1642	-.2146	-.1969	-.0602
V226	.0042	.2831	.0864	.2672	-.3234	.1441	-.0283	.3603	-.0798	-.3490
V227	.7267	-.0084	-.4687	-.0410	-.3070	-.3389	.5252	-.0175	.5772	.5677
V228	.1489	.0577	-.2033	.0725	-.0599	-.0466	-.0554	-.2380	.1589	.3275
V229	-.1771	.5254	-.5650	.5691	-.0218	-.2930	-.0522	.4790	.4072	.0821
V230	.0648	.1921	.0729	.2488	-.4121	-.0151	.8417	-.0529	.0366	.4745
V231	-.2834	.7293	-.3109	.7074	-.4305	.3111	.4739	.3464	-.0736	-.2506
V232	-.3389	.9145	-.4335	.8763	-.5686	.4243	.2868	.5879	-.2157	-.2826
V233	.2194	.3190	-.2528	.3289	-.3665	-.1884	.4324	.4186	.2572	-.0328
V234	.3087	.2633	-.2810	.2794	-.3496	-.2687	.3892	.4475	.3257	-.0160
V235	-.0638	-.5067	.3186	-.5436	.2946	.1514	-.5110	-.4848	-.2763	.0888
V236	-.4693	.0583	.2567	.0195	-.0076	.5466	.0074	-.2273	-.4531	-.2920
V237	-.1478	-.3434	.3951	-.3605	.4967	.3613	-.4537	-.4379	-.5104	-.0802
V238	-.0507	.0336	-.2454	.1918	.3835	-.4628	.0132	.4463	.2654	-.1746
V239	.0141	-.5735	.1596	-.5201	.9572	-.3481	-.5256	-.0558	.0251	-.2336
V240	-.4174	-.1119	.7832	-.1903	-.1618	.8615	-.2315	-.4260	-.8764	-.3358
V241	.0410	.1922	.1156	.0421	-.6686	.4839	.1852	-.3318	-.2007	.2334

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V210	V211	V212	V213	V214	V215	V216	V217	V218	V219
V101	-.2271	-.2693	.0713	-.1405	-.1627	.0425	-.2955	-.5752	.2903	-.4883
V102	-.0952	.0234	-.0411	-.1631	.1157	-.0632	-.0566	-.4301	-.0802	-.4228
V103	-.2503	.1856	-.1643	.1492	.2428	-.2250	-.0763	-.3055	-.2855	-.2128
V104	.0308	-.0209	.0197	-.0419	.0216	.0302	-.0546	-.4397	-.2478	-.1806
V105	.1251	.1575	.0204	-.1554	.0806	.1611	-.3735	-.2991	-.5374	.0960
V106	-.1059	.1029	.0669	.7397	.0875	-.1668	.3078	.3430	.1692	.4249
V107	-.0626	-.2783	.2344	.7526	-.2863	.0099	.1224	.5198	.2151	.5483
V108	-.0296	.7627	-.2556	-.0879	.7508	-.2668	.2176	-.1789	-.2239	-.1900
V109	.6710	-.1660	.2121	-.1416	-.1760	.4155	.5274	.5938	-.1629	.5905
V110	.9182	-.1019	.5586	-.2094	-.0509	.8606	.3134	-.1668	-.2024	.5270
V111	.0057	-.2199	-.0892	.6800	-.2744	-.1876	.4318	.9185	-.1640	.6953
V112	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V113	-.0944	.0599	.0882	.7551	.0435	-.1465	.2071	.4126	.1509	.4667
V114	-.3498	-.0733	-.0649	.1443	-.1221	-.0996	-.1629	.3628	-.1277	.3272
V115	-.3106	-.0609	-.5713	-.1515	-.0156	-.0210	-.0319	.1371	-.5471	.0852
V116	.0304	-.2031	-.4864	-.1437	-.1088	.2067	.3349	-.0222	-.2022	.0663
V117	-.3741	-.5470	-.2598	-.1999	-.5304	.2939	-.3772	.0248	-.1463	-.0094
V118	.1480	-.2465	.5933	.2994	-.2485	.0669	-.0064	-.2010	.5167	-.1008
V119	-.2168	.4179	-.5884	-.3969	.4769	-.0971	-.0071	-.1616	-.5345	-.2005
V120	.3790	-.5493	-.3538	-.0159	-.4969	.3891	.3466	.4526	-.1711	.4087

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V210	V211	V212	V213	V214	V215	V216	V217	V218	V219
V121	-.2340	.3120	-.1141	.0787	.3509	-.3922	.0949	.0233	-.3276	-.0554
V122	-.2900	.0789	-.5920	-.1476	.1113	-.0878	.0246	.1882	-.5636	.1373
V123	-.3488	-.2526	-.5473	-.0841	-.2928	-.4251	-.0339	.2894	-.2239	-.2242
V124	-.6855	-.0663	-.3012	-.2705	-.0944	-.4248	-.7772	-.5008	.1439	-.7935
V125	-.7605	.0016	-.3263	-.2347	-.0256	-.5239	-.7341	-.4596	.2318	-.8384
V126	-.0232	-.1922	-.0835	.7859	-.2424	-.1926	.4177	.8667	-.2034	.7195
V127	.9138	-.1119	.5430	-.1217	-.0653	.8404	.3552	-.1021	-.2423	.5980
V128	-.0254	-.1842	-.0949	.7805	-.2353	-.2017	.4261	.8817	-.2090	.7166
V129	-.4707	.5348	-.1212	-.2622	.5138	-.3708	-.6120	-.3916	-.0375	-.6537
V130	-.0498	-.1765	-.0359	.8831	-.2182	-.1710	.3632	.7311	-.2085	.7121
V131	-.0678	-.1589	-.1264	.8573	-.1945	-.1999	.3933	.7526	-.2760	.6901
V132	.8392	-.1731	.4632	.2040	-.1503	.6991	.5045	.2622	-.3160	.8470
V133	.9030	-.1334	.5267	-.0084	-.0926	.8102	.4074	.0056	-.2753	.6904
V134	.5985	.1304	.2150	-.1519	.1628	.4773	.3334	-.0048	-.3084	.3212
V135	.5074	.0194	.0709	.1706	-.0136	.1709	.6298	.7167	-.2535	.6886
V136	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V137	.0700	.2200	-.1340	-.2762	.1764	-.2490	.3137	.3835	.1235	-.1190
V138	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V139	-.0766	.2322	.0513	.5740	.2247	-.1547	.2216	.3033	.0661	.3098
V140	.9329	-.1132	.5257	-.2398	-.0689	.8398	.3594	-.0785	-.2141	.5479
V141	.7091	.1064	.4413	.2608	.1296	.5302	.5222	.2590	-.1362	.7191

BIVARIATE COLLELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

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FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY 81/02/23. 18.31.42.

PEARSON CORRELATION COEFFICIENTS

	V210	V211	V212	V213	V214	V215	V216	V217	V218	V219
V201	-.0853	.1535	-.1057	-.1019	.2270	-.1637	.0406	-.2544	-.2392	-.3248
V202	-.3418	.1615	-.0276	-.4091	.1164	-.0840	-.6723	-.4787	.2985	-.5516
V203	-.0988	.1290	-.1373	-.0792	.2055	-.1928	.0804	-.1481	-.2419	-.3044
V204	-.2779	-.1940	-.2155	.2218	-.3422	-.3722	-.2144	.6703	-.2254	.2040
V205	-.5182	.1033	.0425	-.2010	.0989	-.2563	-.7642	-.7794	.2395	-.7733
V206	.7199	-.0730	.3141	-.1993	.0556	.7488	.3542	-.3290	-.2122	.2765
V207	-.2267	.2964	-.3150	.1798	.3133	-.4217	.2225	.3865	-.3799	.0072
V208	.7815	-.0602	.1471	.1119	-.0112	.5011	.8835	.5232	-.2602	.7921
V209	.9443	-.3007	.5514	-.1748	-.2229	.9386	.4069	-.1330	-.0452	.5693
V210	1.0000	-.1324	.5938	-.1434	-.0535	.8679	.5740	.0046	-.0311	.6008
V211	-.1324	1.0000	-.3438	-.1903	.9836	-.4300	.1415	-.1454	-.4301	-.3321
V212	.5938	-.3438	1.0000	.1424	-.3048	.6757	-.0003	-.1870	.5915	.2921
V213	-.1434	-.1903	.1424	1.0000	-.2239	-.2046	.2483	.4964	.0586	.5371
V214	-.0535	.9836	-.3048	-.2239	1.0000	-.3376	.2167	-.2051	-.4006	-.3283
V215	.8679	-.4300	.6757	-.2046	-.3376	1.0000	.2360	-.2487	.1916	.4802
V216	.5740	.1415	-.0003	.2483	.2167	.2360	1.0000	.4754	-.2105	.6210
V217	.0046	-.1454	-.1870	.4964	-.2051	-.2487	.4754	1.0000	-.1726	.5874
V218	-.0311	-.4301	.5915	.0586	-.4006	.1916	-.2105	-.1726	1.0000	-.1750
V219	.6008	-.3321	.2921	.5371	-.3283	.4802	.6210	.5874	-.1750	1.0000
V220	-.0761	-.3921	.1955	.1909	-.3561	-.0126	-.0615	-.2599	.3306	-.2244

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

V221	-.1367	-.0541	.1434	.1762	-.0213	-.1030	.0003	-.3210	.2732	-.3556
V222	-.1814	.9415	-.3694	-.1830	.9606	-.4444	.1692	-.2289	-.3757	-.4006
V223	-.2928	-.0697	.1495	-.2699	-.1382	.0188	-.8820	-.6378	.1026	-.4254
V224	-.2096	.9458	-.4220	-.1755	.9633	-.4811	.1894	-.1564	-.4105	-.4089
V225	-.0296	.2350	.4409	.3117	.2430	-.0502	-.0376	-.1789	.5234	-.1380
V226	-.1858	.9709	-.4116	-.1710	.9842	-.4672	.2045	-.1787	-.3975	-.3927
V227	.6374	.0722	.4902	.5452	.1245	.4751	.6042	.0835	-.1240	.7025
V228	.6002	-.0870	.5996	.1519	-.0756	.1055	.2425	.0858	.5091	-.0511
V229	.4305	.0370	-.2511	-.4041	.0871	-.1076	.4159	.2606	-.1467	-.0978
V230	.1669	.0444	-.3236	-.2778	.1521	.2443	.1013	-.2210	-.2616	-.2412
V231	-.1375	.5402	-.4140	-.1274	.6078	-.5023	.2312	-.3469	-.5037	-.4283
V232	-.1677	.2591	-.2181	-.1908	.3546	-.1842	.0819	-.3946	-.2617	-.3743
V233	-.0357	.4734	-.7237	-.1030	.5423	-.2674	.3975	-.0049	-.7047	.0429
V234	.0263	.4492	-.6759	-.0382	.5186	-.2260	.4513	.0776	-.6607	.1435
V235	-.0764	-.5908	.6696	.2259	-.6594	.4357	-.4404	-.0058	.7080	.1792
V236	-.2773	-.0317	.4653	.1343	-.0605	-.0518	-.3529	-.3816	.3858	-.3371
V237	-.2214	-.4656	.6939	.4729	-.5645	.1663	-.6598	-.0416	.5633	-.0392
V238	-.0632	-.1540	-.1334	.1802	-.1322	-.1884	.2705	.6647	-.0000	.1243
V239	-.2415	-.1978	-.1510	.2161	-.3507	-.2859	-.2388	.6349	-.1163	.2535
V240	-.4910	.0359	.1147	-.1929	-.0056	-.1549	-.8667	-.7215	.3685	-.6565
V241	.1466	.2114	.1336	-.2284	.2505	.2530	-.1026	-.7641	.0100	-.1794

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V220	V221	V222	V223	V224	V225	V226	V227	V228	V229
V101	.5630	.5324	-.0097	.2010	-.0361	.3210	-.0948	-.1941	.0089	.1526
V102	.5164	.5952	.2367	-.0024	.2674	.3354	.1795	-.0499	.0773	.3848
V103	.2106	.3245	.4377	.1433	.3299	.0737	.2978	.1151	-.2314	.1867
V104	.5342	.5938	.1617	.2067	.1027	.4336	.0633	.1546	.0395	.2641
V105	-.2767	-.2807	.0599	.6738	-.0328	-.2382	-.0007	.1299	-.4893	-.3385
V106	-.1284	-.0765	.1245	-.2347	.0153	.0205	.1034	.4648	.0634	-.4245
V107	-.2360	-.3315	-.2760	-.1931	-.3058	-.1625	-.2949	.3461	-.0877	-.3832
V108	-.1453	.0817	.7433	-.0521	.6149	-.1000	.7410	.1551	.1278	-.0844
V109	-.3085	-.3965	-.2981	-.4762	-.2492	-.2123	-.2636	.1756	.2356	.5623
V110	-.1554	-.2190	-.1830	.0209	-.2047	-.1069	-.1968	.5943	.3277	.3442
V111	-.1991	-.2807	-.2346	-.4924	-.2624	-.1371	-.2523	.2460	.0322	.1368
V112	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V113	-.1886	-.1615	.0721	-.2444	-.0269	-.0576	.0509	.4509	.0296	-.4151
V114	-.7175	-.7452	-.1708	.0930	-.0608	-.4911	-.1593	-.0950	-.6399	-.1518
V115	-.4478	-.5563	-.0032	-.0806	.0805	-.7645	-.0086	-.2597	-.7822	.1623
V116	.0488	-.0209	-.1056	-.3872	.0494	-.1899	-.0454	-.0733	-.4246	.2446
V117	-.1205	-.3788	-.5624	.1673	-.4164	-.4198	-.5246	-.5062	-.5819	-.0347
V118	.8184	.8679	-.1921	.0450	-.2156	1.0000	-.2070	.3036	.7532	-.0400
V119	-.5997	-.5553	.4935	.0134	.4721	-.8583	.4583	-.2270	-.7132	.1426
V120	.0890	-.1941	-.5067	-.4838	-.4583	-.3426	-.4715	-.1901	-.1119	.3365

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

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FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY 81/02/23. 10.31.42.

PEARSON CORRELATION COEFFICIENTS

	V220	V221	V222	V223	V224	V225	V226	V227	V228	V229
V121	-.2094	-.0386	.4836	-.0663	.4464	-.1433	.3672	.1374	-.2719	.3906
V122	-.6348	-.6941	.1110	-.0964	.1831	-.8536	.1055	-.2140	-.8415	.1358
V123	.4853	.3646	-.2106	-.2048	-.1616	.1652	-.1765	-.5156	.2133	.4852
V124	.4073	.3594	.0382	.6025	-.0366	.1371	-.0126	-.6845	-.0446	-.1416
V125	.3853	.3812	.1215	.5309	.0461	.1750	.0699	-.7113	.0055	-.1129
V126	-.1857	-.2562	-.2093	-.4625	-.2218	-.1279	-.2168	.3498	.0315	-.0083
V127	-.1589	-.2254	-.1927	-.0147	-.2150	-.1078	-.2069	.6484	-.0022	-.0252
V128	-.1936	-.2619	-.2093	-.4817	-.2098	-.1333	-.2087	.3420	-.0300	-.0040
V129	-.3372	-.1776	.4893	.4678	.5228	-.3084	.4974	-.3539	-.2839	.3131
V130	-.1206	-.1788	-.1768	-.3660	-.1977	-.0697	-.1902	.4671	-.0790	-.1750
V131	-.1091	-.1772	-.1629	-.4293	-.1619	-.1249	-.1577	.4345	-.0981	-.1523
V132	-.2315	-.3197	-.2614	-.2119	-.2778	-.1594	-.2713	.7451	-.0380	-.0222
V133	-.1784	-.2535	-.2155	-.0736	-.2379	-.1250	-.2294	.7011	-.0484	.0762
V134	-.2166	-.1996	-.0747	-.2475	.1487	-.1491	.0769	.4355	-.0819	-.1733
V135	-.3306	-.3602	-.0517	-.5026	-.1377	-.2276	-.0771	.3195	.2227	.4159
V136	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V137	.0192	.1049	.1619	-.4075	.1408	.1490	.1896	-.3004	.5743	.5881
V138	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V139	-.2436	-.1920	.2339	-.1935	.1170	-.1933	.2125	.3755	.0523	-.3803
V140	-.1753	-.2444	-.2019	-.0426	.2198	-.1207	-.2131	.5465	.2895	.6860
V141	-.3544	-.3659	.0280	-.2508	-.0811	-.2579	.0042	.7267	.1489	-.1771

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V220	V221	V222	V223	V224	V225	V226	V227	V228	V229
V201	.3738	.4948	.3755	-.0683	.3598	.2357	.2831	-.0084	.0577	.5254
V202	-.2356	-.2340	.0244	.5948	.0504	-.2022	.0864	-.4687	-.2033	-.5650
V203	.3531	.4591	.3425	-.1694	.3561	.1882	.2672	-.0410	.0725	.5691
V204	-.2116	-.3118	-.3877	.0336	-.2862	-.1077	-.3234	-.3070	-.0599	-.0218
V205	.3728	.4613	.2068	.7318	.1608	.3607	.1441	-.3389	-.0466	-.2930
V206	.0784	.0017	-.0700	-.1909	-.0088	-.1642	-.0283	.5252	-.0554	-.0522
V207	-.2553	-.1052	.3964	-.3702	.4670	-.2146	.3603	-.0175	-.2380	.4790
V208	-.2254	-.2722	-.1270	-.7218	-.0893	-.1969	-.0798	.5772	.1589	.4072
V209	.0178	-.1295	-.3405	-.1114	-.3850	-.0602	-.3490	.5677	.3275	.0821
V210	-.0761	-.1367	-.1814	-.2928	-.2096	-.0296	-.1858	.6374	.6002	.4305
V211	-.3921	-.0541	.9415	-.0697	.9458	-.2350	.9709	.0722	-.0870	.0370
V212	.1955	.1434	-.3694	.1495	-.4220	.4409	-.4116	.4902	.5996	-.2511
V213	.1909	.1762	-.1830	-.2699	-.1755	.3117	-.1710	.5452	.1519	-.4041
V214	-.3561	-.0213	.9606	-.1382	.9633	-.2430	.9842	.1245	-.0756	.0871
V215	-.0126	-.1830	-.4444	.0188	-.4811	-.0502	-.4672	.4751	.1055	-.1076
V216	-.0615	.0003	.1692	-.8820	.1894	-.0376	.2045	.6042	.2425	.4159
V217	-.2599	-.3210	-.2289	-.6378	-.1564	-.1789	-.1787	.0835	.0858	.2606
V218	.3306	.2732	-.3757	.1026	-.4105	.5234	-.3975	-.1240	.5091	-.1467
V219	-.2244	-.3556	-.4006	-.4254	-.4089	-.1380	-.3927	.7025	-.0511	-.0978
V220	1.0000	.9281	-.2486	-.0020	-.2780	.8202	-.2674	.0344	.6335	.0700

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

V221	.9281	1.0000	.0881	-.0396	.0601	.8657	.0711	.0889	.6854	.1054
V222	-.2486	.0881	1.0000	-.0944	.9441	-.1712	.9726	.0502	-.0737	.1898
V223	-.0020	-.0396	-.0944	1.0000	-.2006	.0421	-.1734	-.3133	-.2855	-.4645
V224	-.2780	.0601	.9441	-.2006	1.0000	-.1914	.9847	.0282	-.1103	.1407
V225	.8202	.8657	-.1712	.0421	-.1914	1.0000	-.1841	.1786	.7532	-.0400
V226	-.2674	.0711	.9726	-.1734	.9847	-.1841	1.0000	.0564	-.0679	.1125
V227	.0344	.0889	.0502	-.313_	.0282	.1786	.0564	1.0000	.2265	-.3445
V228	.6335	.6854	-.0737	-.2855	-.1103	.7532	-.0679	.2265	1.0000	.2279
V229	.0700	.1054	.1898	-.4645	.1407	-.0400	.1125	-.3445	.2279	1.0000
V230	.1518	.0622	.1491	-.2033	.1517	-.3781	.1667	-.1108	-.0878	.1430
V231	.3593	.5700	.6690	-.1048	.6988	.1662	.6777	.1853	.0913	.2733
V232	.1913	.3363	.5314	-.0098	.4448	.0320	.4022	.0220	-.1538	.4737
V233	-.3219	-.2361	.6054	-.2955	.5517	-.6236	.5692	.1434	-.5115	.2522
V234	-.3913	-.3102	.5794	-.3449	.5200	-.6553	.5387	.1968	-.5206	.2458
V235	.0996	-.0464	-.6900	.4335	-.7071	.4008	-.6988	-.0628	.1609	-.4572
V236	.4432	.5306	-.1406	.2896	.0159	.6915	-.0425	.1365	.3424	-.4623
V237	.2646	.1531	-.6126	.5474	-.5956	.5080	-.5999	-.1267	.3548	-.4701
V238	-.0514	-.1244	-.1932	-.6529	-.0061	-.1864	-.0939	-.1571	.1826	.3328
V239	-.3301	-.4458	-.4281	.0953	-.3445	-.1041	-.3538	-.2791	-.1047	-.1957
V240	.1516	.1768	.0230	.8519	-.0186	.2040	.0031	-.3622	-.1257	-.6215
V241	.1558	.2608	.3317	.4771	.1456	.2063	.2223	.2388	-.1270	-.1774

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V230	V231	V232	V233	V234	V235	V236	V237	V238	V239
V101	.3374	.3065	.7095	.0633	.0118	-.0905	.2193	-.0929	-.0810	-.6807
V102	.2606	.7144	.8479	.1946	.1226	-.3930	.2547	-.2617	.0065	-.6564
V103	.1676	.5978	.9075	.4969	.4682	-.4291	-.0985	-.3659	-.2191	-.5633
V104	-.0057	.6705	.7818	.1412	.0631	-.2451	.2548	-.1231	-.3843	-.5193
V105	-.2161	.0328	.0350	.0980	.0514	.0493	-.0093	.1919	-.6125	.2012
V106	-.1500	-.2603	-.2590	.1347	.2263	.1397	-.2100	-.0524	-.0489	.0605
V107	-.0920	-.5407	-.3144	-.0284	.0832	.2970	-.2378	.3173	.3294	.2816
V108	.1798	.3676	.0181	.4237	.4051	-.4325	-.2030	-.4018	-.3581	-.2277
V109	-.1773	-.3641	-.3964	-.1490	-.0941	-.0012	-.3748	-.0206	.3864	.3831
V110	.0029	-.6060	-.3716	-.3623	-.3028	.2805	-.2842	.2444	-.2540	-.1726
V111	-.2316	-.3685	-.2789	.0675	.1609	.0543	-.4652	-.0102	.4554	.5330
V112	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V113	-.1166	-.3233	-.2859	.1343	.2338	.1415	-.2620	-.0173	.0507	.1259
V114	-.4341	-.4829	-.1168	-.0308	.0451	.2601	-.0947	.1139	.2046	.4610
V115	.4422	.0732	.3400	.6156	.6220	-.4449	-.5029	-.5031	.3527	.0015
V116	.2751	.2725	.3565	.3856	.3698	-.3152	-.0818	-.5532	.1955	-.3438
V117	.2646	-.2373	-.0143	.0250	.0102	.0808	-.0883	.0488	.3386	.2291
V118	-.3781	.1662	.0320	-.6236	-.6553	.4008	.6915	.5000	-.2232	-.2071
V119	.5657	.2415	.4343	.0292	.0271	-.6524	-.6162	-.7164	.0467	-.2766
V120	.5399	-.1538	-.1438	.2591	.2697	-.2188	-.5463	-.3155	.5697	.1502

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V230	V231	V232	V233	V234	V235	V236	V237	V238	V239
V121	-.0786	.3907	.7921	.4203	.4464	-.4072	-.1912	-.3788	.0528	-.3337
V122	.3316	.0088	.2922	.6533	.6784	-.4364	-.5584	-.5536	.2969	.0464
V123	.2709	.2588	-.0059	.0088	-.0653	-.2542	-.1278	-.0680	.3594	.2716
V124	.3781	.1913	.2067	-.0687	-.1697	.0257	.1449	.2797	-.1886	-.0676
V125	.3377	.2060	.2593	-.0856	-.1831	.0393	.1723	.2798	-.1599	-.0933
V126	-.2130	-.3100	-.2530	.1092	.2004	.0424	-.3884	-.0215	.4163	.4861
V127	-.2225	-.2959	-.2375	.0897	.1790	.0617	-.3586	.0883	-.2383	-.1428
V128	-.2129	-.3072	-.2668	.1050	.1959	.0354	-.3784	-.0306	.4415	.4997
V129	.1922	.1448	.1461	.1225	.0939	-.1669	.1593	.0651	-.0023	-.0405
V130	-.1942	-.2323	-.1829	.1385	.2227	.0540	-.2859	.5080	.2951	.3775
V131	-.0778	-.1712	-.1849	.2136	.2895	-.0444	-.3249	-.4356	.3729	.3744
V132	-.2097	-.2973	-.2669	.1090	.1991	.0314	-.3636	-.0366	-.0384	.0705
V133	-.1716	-.2553	-.2242	.1399	.2256	.0196	-.3501	-.0888	-.1848	-.0855
V134	.0630	.2166	-.2528	-.0333	-.0571	-.1954	.4335	-.0678	.1629	.0015
V135	-.1632	-.2866	-.3134	.1174	.1915	-.1123	-.6130	-.1960	.2312	.3763
V136	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V137	-.1477	-.0411	.2677	-.1811	-.1774	-.0945	-.1782	-.0622	.2491	.2488
V138	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000	99.0000
V139	.1203	-.2108	-.2527	.2574	.3371	-.0471	-.3528	-.1185	.0789	.0648
V140	-.1508	-.3417	-.2992	-.1850	-.1490	.0161	-.3963	-.0184	-.1934	-.1093
V141	.0640	-.2834	.3389	.2194	.3087	-.0638	-.4693	-.1478	-.0507	.0141

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 18.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V230	V231	V232	V233	V234	V235	V236	V237	V238	V239
V201	.1921	.7293	.9145	.3190	.2633	-.5067	.0583	-.3434	.0336	-.5735
V202	.0729	-.3109	-.4335	-.2528	-.2810	.3186	.2567	.3951	-.2454	.1596
V203	.2488	.7074	.8763	.3289	.2794	-.5436	.0195	-.3605	.1918	-.5201
V204	-.4121	-.4305	.5686	-.3665	-.3496	.2946	-.0076	.4967	.3835	.9572
V205	-.0151	.3111	.4243	-.1884	-.2687	.1514	.5466	.3613	-.4628	-.3481
V206	.8417	.4739	.2868	.4324	.3892	-.5110	.0074	-.4537	.0132	-.5256
V207	-.0529	.3464	.5879	.4186	.4475	-.4848	-.2273	-.4379	.4463	-.0558
V208	.0366	-.0736	-.2157	.2572	.3257	-.2763	-.4531	-.5104	.2654	.0251
V209	.4745	-.2506	-.2826	-.0328	-.0160	.0888	-.2920	-.0802	-.1746	-.2336
V210	.1669	-.1375	-.1677	-.0357	.0263	-.0764	-.2773	-.2214	-.0632	-.2415
V211	.0444	.5482	.2591	.4734	.4492	-.5908	-.0317	-.4656	-.1540	-.1978
V212	-.3236	-.4140	-.2101	-.7237	-.6759	.6696	.4653	.6939	-.1334	-.1510
V213	-.2778	.1274	-.1908	-.1030	-.0382	.2259	.1343	.4729	.1802	.2161
V214	.1521	.6078	.3546	.5423	.5186	-.6594	-.0605	-.5645	-.1322	-.3507
V215	.2443	-.5023	-.1842	-.2674	-.2260	.4357	-.0518	.1663	-.1884	-.2859
V216	.1013	.2312	.0819	.3975	.4513	-.4404	-.3529	-.6598	.2705	-.2388
V217	-.2210	-.3469	-.3946	-.0049	.0776	-.0058	-.3816	-.0416	.6647	.6349
V218	-.2616	-.5037	-.2617	-.7047	-.6607	.7080	.3858	.5633	.0000	-.1163
V219	-.2412	-.4283	-.3743	.0429	.1435	.1792	-.3371	-.0392	.1243	.2535
V220	.1518	.3593	.1913	-.3219	-.3913	.0996	.4432	.2646	-.0514	-.3301

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

V221	.0622	.5700	.3363	-.2361	-.3102	-.0464	.5306	.1531	-.1244	-.4458
V222	.1491	.6690	.5314	.6054	.5794	-.6900	.1406	-.6126	-.1932	-.4281
V223	-.2033	.1840	-.0098	-.2955	-.3449	.4335	.2896	.5474	-.6529	.0953
V224	.1517	.6988	.4448	.5517	.5200	-.7071	.0159	-.5956	-.0061	-.3445
V225	-.3781	.1662	.0320	-.6236	-.6553	.4008	.6915	.5080	-.1864	-.1841
V226	.1667	.6777	.4022	.5692	.5387	-.6988	-.0425	-.5999	-.0939	-.3538
V227	-.1108	.1853	.0220	.1434	.1968	-.0628	.1365	-.1267	-.1571	-.2791
V228	-.0878	.0913	-.1538	-.5115	-.5206	.1609	.3424	.3548	.1826	-.1047
V229	.1430	.2733	.4737	.2522	.2458	-.4572	-.4623	-.4701	.3328	-.1957
V230	1.0000	.4118	.2686	.5888	.5389	-.6522	-.3876	-.5317	.3062	-.4363
V231	.4118	1.0000	.6955	.5327	.4416	-.7789	.1212	-.5627	-.0844	-.6118
V232	.2686	.6955	1.0000	.5484	.5080	-.5734	-.1549	-.5656	-.1820	-.7506
V233	.5888	.5327	.5484	1.0000	.9904	-.8606	-.6608	-.9312	.0105	-.4098
V234	.5389	.4416	.5080	.9904	1.0000	-.8143	-.7087	-.9428	.0474	-.3757
V235	-.6522	-.7789	-.5734	-.8606	-.8143	1.0000	.4455	.8539	-.2310	.4247
V236	-.3876	.1212	-.1549	-.6608	-.7087	.4455	1.0000	.6417	-.1726	-.0305
V237	-.5317	-.5627	-.5656	-.9312	-.9428	.8539	.6417	1.0000	-.0864	.5483
V238	.3062	-.0844	-.1820	.0105	.0474	-.2310	-.1726	-.0864	1.0000	.2939
V239	-.4363	-.6118	-.7506	-.4098	-.3757	.4247	-.0305	.5483	.2939	1.0000
V240	-.0951	-.0917	-.0549	-.3583	-.4121	.4356	.5272	.5894	-.5163	-.0678
V241	-.0831	.3213	.4503	.1818	.1381	-.0003	.1260	-.1762	-.9332	-.6144

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 10.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V240	V241
V101	.3421	.3056
V102	.0500	.2380
V103	.0772	.3965
V104	.0586	.5173
V105	.2751	.4320
V106	-.0046	.0207
V107	-.1526	-.3857
V108	.0701	.3921
V109	-.7453	-.4457
V110	-.2841	.2751
V111	-.6402	-.5552
V112	99.0000	99.0000
V113	-.1210	-.0876
V114	-.0708	-.3471
V115	-.2416	-.2771
V116	-.3237	-.0057
V117	.0513	-.3717
V118	.1043	.2481
V119	-.0552	.0819
V120	-.5743	-.5094

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 16.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V240	V241
V121	-.2131	.0929
V122	-.2616	-.2455
V123	-.2198	.3793
V124	.7185	.1629
V125	.7126	.1491
V126	-.5831	-.5069
V127	-.3325	.2533
V128	-.5947	-.5324
V129	.6136	-.0085
V130	-.4620	-.3699
V131	-.5033	-.4302
V132	-.5503	.0160
V133	-.4024	.1901
V134	-.2898	-.1319
V135	-.7666	-.3067
V136	99.0000	99.0000
V137	-.3584	-.2854
V138	99.0000	99.0000
V139	-.0589	-.0916
V140	-.3667	.2046
V141	-.4174	.0410

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

1 81/02/23. 10.31.42.

FILE FUEL (CREATION DATE = 81/02/23.) VARIABLES STUDY

PEARSON CORRELATION COEFFICIENTS

	V240	V241
V201	-.1119	.1922
V202	.7832	.1156
V203	-.1903	.0421
V204	-.1618	-.6686
V205	.8615	.4839
V206	-.2315	.1852
V207	-.4260	-.3318
V208	-.8764	-.2007
V209	-.3358	.2334
V210	-.4918	.1466
V211	.0359	.2114
V212	.1147	.1336
V213	-.1929	-.2284
V214	-.0056	.2505
V215	-.1549	.2530
V216	-.0667	-.1026
V217	-.7215	.7641
V218	.3605	.0100
V219	-.6565	-.1794
V220	.1516	.1558

BIVARIATE CORRELATION MATRIX OF EMISSION VARIABLES VERSUS EMISSION VARIABLES (Cont'd)

V221	.1768	.2608
V222	.0230	.3317
V223	.0519	.4771
V224	-.0186	.1456
V225	.2040	.2063
V226	.0031	.2223
V227	-.3622	.2388
V228	-.1257	-.1270
V229	-.6215	-.1774
V230	-.0951	-.0831
V231	-.0917	.3213
V232	-.0549	.4503
V233	-.3583	.1818
V234	-.4121	.1381
V235	.4356	-.0003
V236	.5272	.1260
V237	.5094	-.1762
V238	-.5163	-.9332
V239	-.0678	-.6144
V240	1.0000	.4170
V241	.4170	1.0000

(COEFFICIENT / CASES / SIGNIFICANCE) (99.0000 MEANS UNCOMPUTABLE)

EXAMPLE OF STEPWISE LINEAR REGRESSION ANALYSIS

STEP NO. 0
STD. ERROR OF EST. 2.6249

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE
RESIDUAL	68.900000	10	6.890000

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE	LEVEL
(Y-INTERCEPT	14.600)					

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER	LEVEL
NITROGEN	1	-.77534	1.00000	13.56	1
AROMATIC	2	-.43856	1.00000	2.14	1
OLEFIN	3	.42927	1.00000	2.03	1
GUM	4	-.20299	1.00000	.78	1
EP	5	-.29706	1.00000	.87	1
HC	6	-.07725	1.00000	.05	0
CO	7	-.37217	1.00000	1.45	0
NOX	8	-.41119	1.00000	1.83	0
FUEL	9	.12834	1.00000	.15	0
TOTALD	10	-.07697	1.00000	.05	0
TPHEN	11	-.36392	1.00000	1.37	0
PART	12	-.52852	1.00000	3.49	0
DAP	14	-.15899	1.00000	.23	0

STEP NO. 1
VARIABLE ENTERED 1 NITROGEN
MULTIPLE R .7753
MULTIPLE R-SQUARE .6011
ADJUSTED R-SQUARE .5568
STD. ERROR OF EST. 1.7474

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	41.419069	1	41.41907	13.56
RESIDUAL	27.480931	9	3.053437	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE	LEVEL
(Y-INTERCEPT		15.987)					
NITROGEN	1	-.006	.002	-.775	1.00000	13.56	1

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER	LEVEL
AROMATIC	2	-.63772	.99781	5.48	1
OLEFIN	3	.35478	.92309	1.15	1
GUM	4	-.15609	.94162	.20	1
EP	5	-.09478	.90407	.07	1
HC	6	-.37622	.95977	1.32	0
CO	7	-.52013	.99746	3.09	0
NOX	8	-.23000	.87845	.48	0
FUEL	9	.32583	.99020	.95	0
TOTALD	10	.20400	.93253	.35	0
TPHEN	11	-.10140	.84521	.08	0
PART	12	-.47431	.90078	2.32	0
DAP	14	-.29028	.99902	.74	0

STEP NO. 2
VARIABLE ENTERED 2 AROMATIC
MULTIPLE R .8737
MULTIPLE R-SQUARE .7634
ADJUSTED R-SQUARE .7042
STD. ERROR OF EST. 1.4276

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	52.595026	2	26.29751	12.90
RESIDUAL	16.304974	8	2.038122	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE	LEVEL
(Y-INTERCEPT		17.080)					
NITROGEN	1	-.006	.001	-.756	.99781	19.30	1
AROMATIC	2	-.008	.037	-.403	.99781	5.48	1

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER	LEVEL
OLEFIN	3	.36888	.91195	1.10	1
GUM	4	-.17547	.94060	.22	1
EP	5	-.20459	.89551	.31	1
HC	6	.34083	.30890	.92	0
CO	7	.14577	.18306	.15	0
NOX	8	.45217	.39696	1.80	0
FUEL	9	.31895	.97382	.79	0
TOTALD	10	-.07209	.78291	.04	0
TEPHEN	11	-.29102	.81587	.65	0
PART	12	.31867	.16077	.79	0
BAP	14	-.25475	.97624	.49	0

STEP NO. 3
VARIABLE ENTERED 3 OLEFIN
MULTIPLE R .8919
MULTIPLE R-SQUARE .7956
ADJUSTED R-SQUARE .7079
STD. ERROR OF EST. 1.4186

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	54.813730	3	18.27124	9.08
RESIDUAL	14.086270	7	2.012324	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE	LEVEL
(Y INTERCEPT		16.293)					
NITROGEN	1	-.005	.001	-.706	.92371	15.75	1
AROMATIC	2	-.003	.037	-.383	.78492	4.94	1
OLEFIN	3	.309	.295	.188	.91195	1.10	1

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER	LEVEL
GUM	4	-.20077	.93976	.25	1
EP	5	-.15594	.87046	.15	1
HC	6	.44045	.30000	1.44	0
CO	7	.24368	.17531	.38	0
NOX	8	.45935	.39494	1.60	0
FUEL	9	.09592	.51072	.06	0
TOTALD	10	.01791	.73729	.00	0
TEPHEN	11	-.31342	.81587	.65	0
PART	12	.40120	.15774	1.15	0
BAP	14	-.10964	.78472	.07	0

STEP NO. 4
VARIABLE ENTERED 4 GUM
0MULTIPLE R .8965
MULTIPLE R-SQUARE .8038
ADJUSTED R-SQUARE .6730
STD. ERROR OF EST. 1.5010

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	55.381504	4	13.84538	6.15
RESIDUAL	13.518496	6	2.253083	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE	LEVEL
(Y-INTERCEPT		16.372)					
NITROGEN	1	-.005	.001	-.682	.87091	12.40	1
AROMATIC	2	-.033	.040	-.379	.90364	4.33	1
OLEFIN	3	.314	.312	.191	.91113	1.01	1
GUM	4	-.061	.121	-.094	.93976	.25	1

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER	LEVEL
EP	5	-.25930	.73881	.36	1
HC	6	.43620	.29852	1.18	0
CO	7	.29593	.16824	.48	0
NOX	8	.44824	.38968	1.26	0
FUEL	9	.32134	.27685	.58	0
TOTALD	10	-.06468	.63025	.02	0
TFPHEN	11	-.56758	.03623	2.38	0
PART	12	.42512	.15695	1.10	0
BAP	14	.13293	.19338	.09	0

STEP NO. 5
VARIABLE ENTERED 5 EP
0MULTIPLE R .9039
MULTIPLE R-SQUARE .8170
ADJUSTED R-SQUARE .6340
STD. ERROR OF EST. 1.5801

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	56.290427	5	11.25809	4.46
RESIDUAL	12.609573	5	2.521915	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE	LEVEL
(Y-INTERCEPT		24.142)					
NITROGEN	1	-.005	.002	-.634	.75429	8.28	1
AROMATIC	2	-.085	.042	-.392	.97133	4.09	1
OLEFIN	3	.280	.335	.170	.88514	.70	1
GUM	4	-.093	.139	-.144	.79762	.45	1
EP	5	-.028	.046	-.134	.73881	.36	1

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER	LEVEL
HC	6	.36793	.22936	.63	0
CO	7	.23827	.15383	.24	0
NOX	8	.56688	.35663	1.89	0
FUEL	9	.44658	.24660	1.00	0
TOTALD	10	.07286	.48106	.02	0
TFPHEN	11	-.70279	.03287	3.90	0
PART	12	.44213	.15694	.97	0
BAP	14	-.05537	.10750	.01	0

0* * * * * F-LEVELS(.010, .010) OR TOLERANCE INSUFFICIENT FOR FURTHER STEPPING

* * * * * BACKWARD STEPPING BEGINS NOW * * * * *

STEP NO. 6
VARIABLE REMOVED 5 EP
MULTIPLE R .8965
MULTIPLE R-SQUARE .8038
ADJUSTED R-SQUARE .6730
STD. ERROR OF EST. 1.5010

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	55.381504	4	13.84538	6.15
RESIDUAL	13.518496	6	2.253083	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE	LEVEL
(Y-INTERCEPT		16.372)					
NITROGEN	1	-.005	.001	-.682	.87091	12.40	1
AROMATIC	2	-.003	.040	-.379	.98364	4.33	1
OLEFIN	3	.314	.312	.191	.91113	1.01	1
GUM	4	-.061	.121	-.094	.93976	.25	1

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER	LEVEL
EP	5	-.25930	.73881	.36	1
HC	6	.43620	.29852	1.18	0
CO	7	.29593	.16824	.48	0
NOX	8	.44824	.38968	1.26	0
FUEL	9	.32134	.27685	.58	0
TOTALD	10	-.06468	.63025	.02	0
TFPHEN	11	-.56758	.03623	2.38	0
PART	12	.42512	.15695	1.10	0
DAP	14	.13293	.19338	.09	0

STEP NO. 7
VARIABLE REMOVED 4 GUM
MULTIPLE R .8919
MULTIPLE R-SQUARE .7956
ADJUSTED R-SQUARE .7079
STD. ERROR OF EST. 1.4186

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	54.813730	3	18.27124	9.08
RESIDUAL	14.086270	7	2.012324	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE	LEVEL
(Y-INTERCEPT		16.293)					
NITROGEN	1	-.005	.001	-.706	.92371	15.75	1
AROMATIC	2	-.033	.037	-.383	.98492	4.94	1
OLEFIN	3	.309	.295	.188	.91195	1.10	1

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER	LEVEL
GUM	4	-.20077	.93976	.25	1
EP	5	-.15594	.87046	.15	1
HC	6	.44045	.30000	1.44	0
CO	7	.24368	.17531	.38	0
NOX	8	.45935	.39494	1.60	0
FUEL	9	.09592	.51072	.06	0
TOTALD	10	.01791	.73729	.00	0
TFPHEN	11	-.31342	.81587	.65	0
PART	12	.40120	.15774	1.15	0
DAP	14	-.10964	.78472	.07	0

STEP NO. 8
VARIABLE REMOVED 3 OLEFIN
0MULTIPLE R .8737
MULTIPLE R SQUARE .7634
ADJUSTED R-SQUARE .7042
STD. ERROR OF EST. 1.4276

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	52.595026	2	26.29751	12.90
RESIDUAL	16.304974	9	2.038122	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE	LEVEL
(Y-INTERCEPT		17.030)					
NITROGEN	1	-.006	.001	-.756	.99781	19.30	1
AROMATIC	2	-.038	.037	-.403	.99781	5.48	1

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER	LEVEL
OLEFIN	3	.36888	.91195	1.10	1
GUM	4	-.17547	.94060	.22	1
EP	5	-.20459	.89551	.31	1
HC	6	.34003	.30890	.92	0
CO	7	.14577	.18306	.15	0
NOX	8	.45217	.39696	1.80	0
FUEL	9	.31895	.97382	.79	0
TOTALD	10	-.07209	.78291	.04	0
TEPHEN	11	-.29102	.81587	.65	0
PART	12	.31867	.16077	.79	0
BAP	14	-.25475	.97624	.49	0

STEP NO. 9
VARIABLE REMOVED 2 AROMATIC
0MULTIPLE R .7753
MULTIPLE R SQUARE .6011
ADJUSTED R-SQUARE .5568
STD. ERROR OF EST. 1.7474

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	41.419069	1	41.41907	13.56
RESIDUAL	27.480931	9	3.053437	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE	LEVEL
(Y-INTERCEPT		15.987)					
NITROGEN	1	-.006	.002	-.775	1.00000	13.56	1

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER	LEVEL
AROMATIC	2	-.63772	.99781	5.48	1
OLEFIN	3	.35478	.92389	1.15	1
GUM	4	-.15609	.94162	.20	1
EP	5	-.09478	.90407	.07	1
HC	6	-.37622	.95977	1.32	0
CO	7	-.52813	.99746	3.09	0
NOX	8	-.23800	.87845	.46	0
FUEL	9	.32583	.99020	.95	0
TOTALD	10	.20400	.93253	.35	0
TEPHEN	11	-.10140	.84521	.08	0
PART	12	-.47431	.90078	2.32	0
BAP	14	-.29020	.99902	.74	0

0* * * * * F LEVELS(99.000, 99.000) OR TOLERANCE INSUFFICIENT FOR FURTHER STEPPING

1

STEPWISE REGRESSION COEFFICIENTS

0 VARIABLES STEP	0 Y-INTCPT	1 NITROGEN	2 AROMATIC	3 OLEFIN	4 GUM	5 EP	6 HC	7 CO	8 NOX	9 FUEL
0	14.6000*	-.0058	-.0955	.7069	-.1835	.0615	-10.2804	-14.8881	-14.6532	3.0588
1	15.9868*	-.0058*	-.0878	.3839	-.0659	-.0130	-32.2736	-13.3597	-5.7150	4.9285
2	17.0796*	-.0057*	-.0878*	.3095	-.0571	-.0218	39.6978	6.6303	12.4415	3.7473
3	16.2925*	-.0053*	-.0833*	.3095*	-.0607	-.0156	48.3842	10.5270	11.7775	1.4464
4	16.3722*	-.0051*	-.0826*	.3141*	-.0607*	-.0277	47.0670	12.7842	11.3346	6.4474
5	24.1423*	-.0040*	-.0854*	.2802*	-.0932*	-.0277*	43.7349	10.3964	14.4715	9.1693
6	16.3722*	-.0051*	-.0826*	.3141*	-.0607*	-.0277	47.0670	12.7842	11.3346	6.4474
7	16.2925*	-.0053*	-.0833*	.3095*	-.0607	-.0156	48.3842	10.5270	11.7775	1.4464
8	17.0796*	-.0057*	-.0878*	.3095	-.0571	-.0218	39.6978	6.6303	12.4415	3.7473
9	15.9868*	-.0058*	-.0878	.3839	-.0659	-.0130	-32.2736	-13.3597	-5.7150	4.9285

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NOTE-

1) REGRESSION COEFFICIENTS FOR VARIABLES IN THE EQUATION ARE INDICATED BY AN ASTERISK
2) THE REMAINING COEFFICIENTS ARE THOSE WHICH WOULD BE OBTAINED IF THAT VARIABLE WERE TO ENTER IN THE NEXT STEP

STEPWISE REGRESSION COEFFICIENTS

0 VARIABLES STEP	10 TOTALD	11 TEMEN	12 PART	14 BAP
0	-.0397	-.0249	.0327	-1.9266
1	.0689	-.0048	-.0195	-2.2226
2	-.0207	-.0107	.0239	-1.5199
3	.0049	-.0107	.0282	-.6701
4	-.0186	-.0903	.0294	1.6225
5	.0232	-.1133	.0295	-.0754
6	-.0186	-.0903	.0294	1.6225
7	.0049	-.0107	.0282	-.6701
8	-.0207	-.0107	.0239	-1.5199
9	.0689	-.0048	-.0195	-2.2226

NOTE-
1) REGRESSION COEFFICIENTS FOR VARIABLES IN THE EQUATION ARE INDICATED BY AN ASTERISK
2) THE REMAINING COEFFICIENTS ARE THOSE WHICH WOULD BE OBTAINED IF THAT VARIABLE WERE TO ENTER IN THE NEXT STEP

1SUMMARY TABLE 6

STEP NO.	VARIABLE ENTERED	VARIABLE REMOVED	MULTIPLE R	RSQ	INCREASE IN RSQ	F-TO-ENTER	F-TO-REMOVE	NUMBER OF INDEPENDENT VARIABLES INCLUDED
1	1 NITROGEN		.7753	.6011	.6011	13.5647		1
2	2 AROMATIC		.8737	.7634	.1622	5.4835		2
3	3 OLEFIN		.8919	.7956	.0322	1.1026		3
4	4 GUM		.8965	.8038	.0082	.2520		4
5	5 EP		.9039	.8170	.0132	.3604		5
6		5 EP	.8965	.8038	-.0132		.3604	4
7		4 GUM	.8919	.7956	-.0082		.2520	3
8		3 OLEFIN	.8737	.7634	-.0322		1.1026	2
9		2 AROMATIC	.7753	.6011	-.1622		5.4835	1

1LIST OF PREDICTED VALUES, RESIDUALS, AND VARIABLES 7

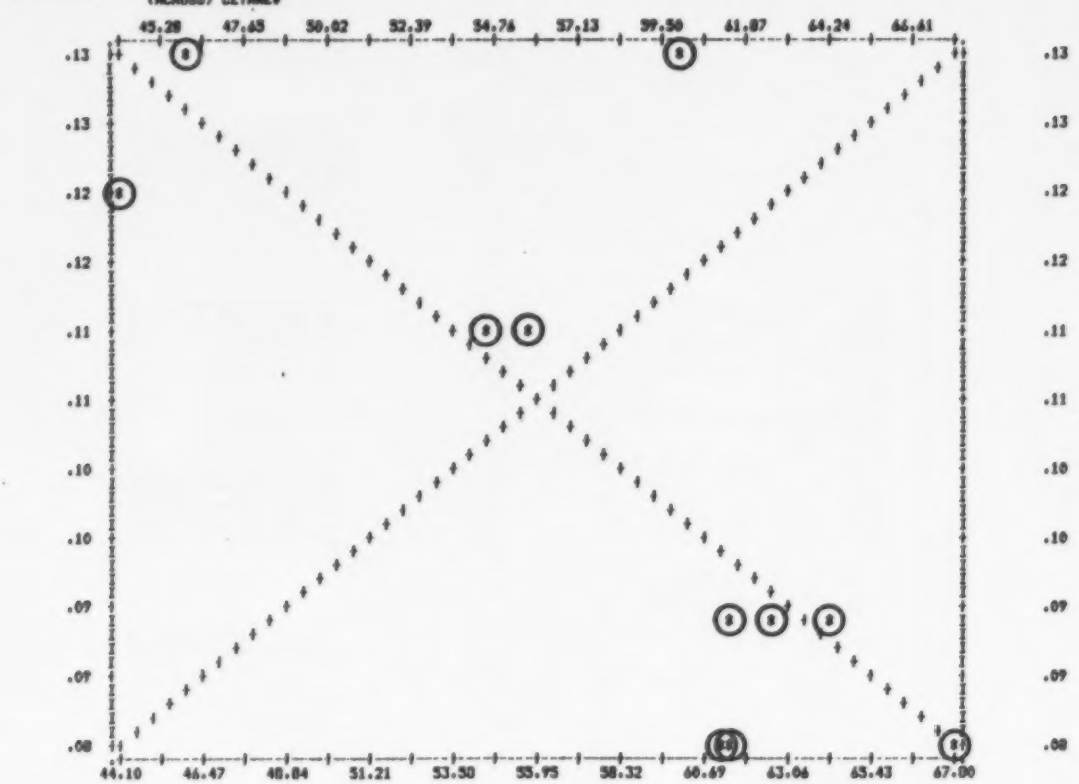
NOTE - NEGATIVE CASE NUMBER DENOTES A CASE WITH MISSING VALUES.
THE NUMBER OF STANDARD DEVIATIONS FROM THE MEAN IS DENOTED BY UP TO 3 ASTERISKS TO THE RIGHT OF EACH RESIDUAL OR VARIABLE.
MISSING VALUES ARE DENOTED BY MORE THAN THREE ASTERISKS.

CASE NO.	LABEL	PREDICTED	RESIDUAL	WEIGHT	VARIABLES 13 SOLUBLES	1 NITROGEN	2 AROMATIC	3 OLEFIN	4 GUM	5 EP
1		15.9868	-.1868	1.000	15.8000	0.0000	5.8000	1.5000	.2000	269.0000
2		15.9868	-.2868	1.000	15.7000	0.0000	2.7000	1.9000	.5000	278.0000
3		13.2032	.1968	1.000	13.4000	479.0000	6.1000	1.5000	.3000	279.0000
4		10.5824	-.0824	1.000	10.5000	930.0000	6.6000	1.5000	.6000	294.0000
5		13.1219	-.4219	1.000	12.7000	493.0000	8.8000	1.9000	14.3000	265.0000
6		15.9577	-2.9577*	1.000	13.0000	5.0000	31.5000	2.9000	2.4000	283.0000
7		15.9868	2.3132*	1.000	18.3000	0.0000	6.8000	6.6000	1.1000	270.0000
8		15.9868	2.8132*	1.000	18.8000	0.0000	4.9000	1.8000	.8000	265.0000
9		15.9868	-2.1868*	1.000	13.8000	0.0000	32.1000	1.0000	1.4000	264.0000
10		15.9868	.5132	1.000	16.5000	0.0000	5.1000	1.0000	1.4000	303.0000
11		11.8143	.2857	1.000	12.1000	718.0000	30.8000	1.2000	2.4000	283.0000

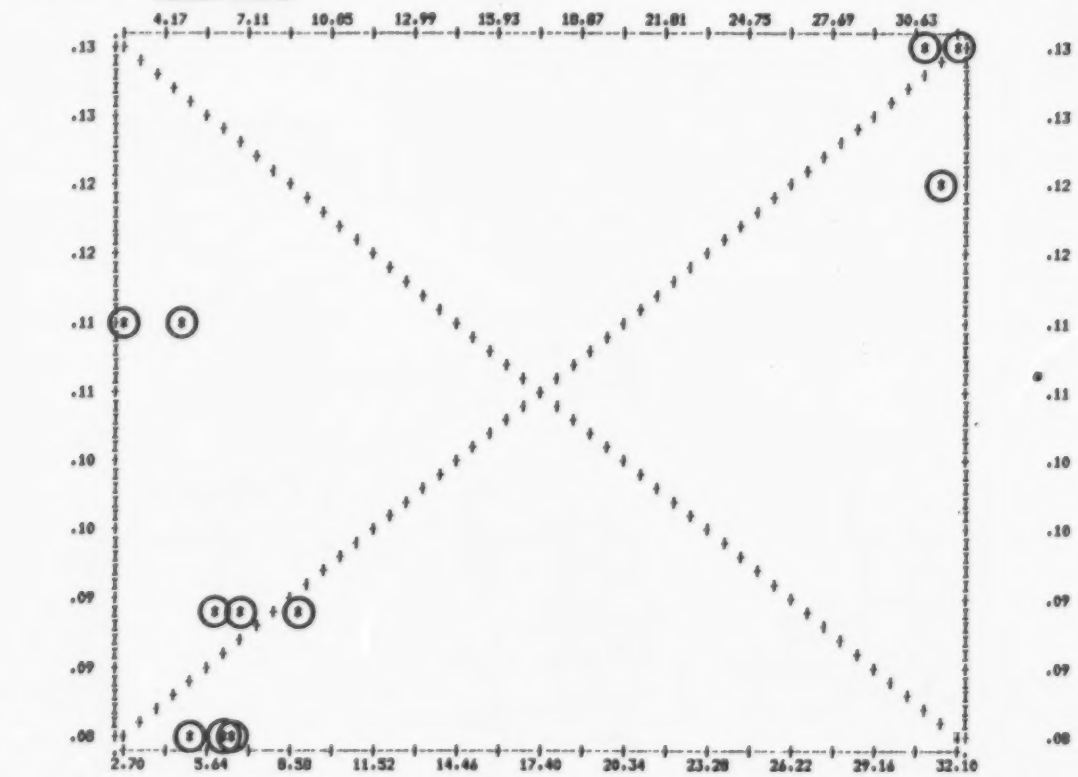
0EACH ASTERISK REPRESENTS ONE STANDARD DEVIATION
1LIST OF PREDICTED VALUES, RESIDUALS, AND VARIABLES (CONTINUED) 8

SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES

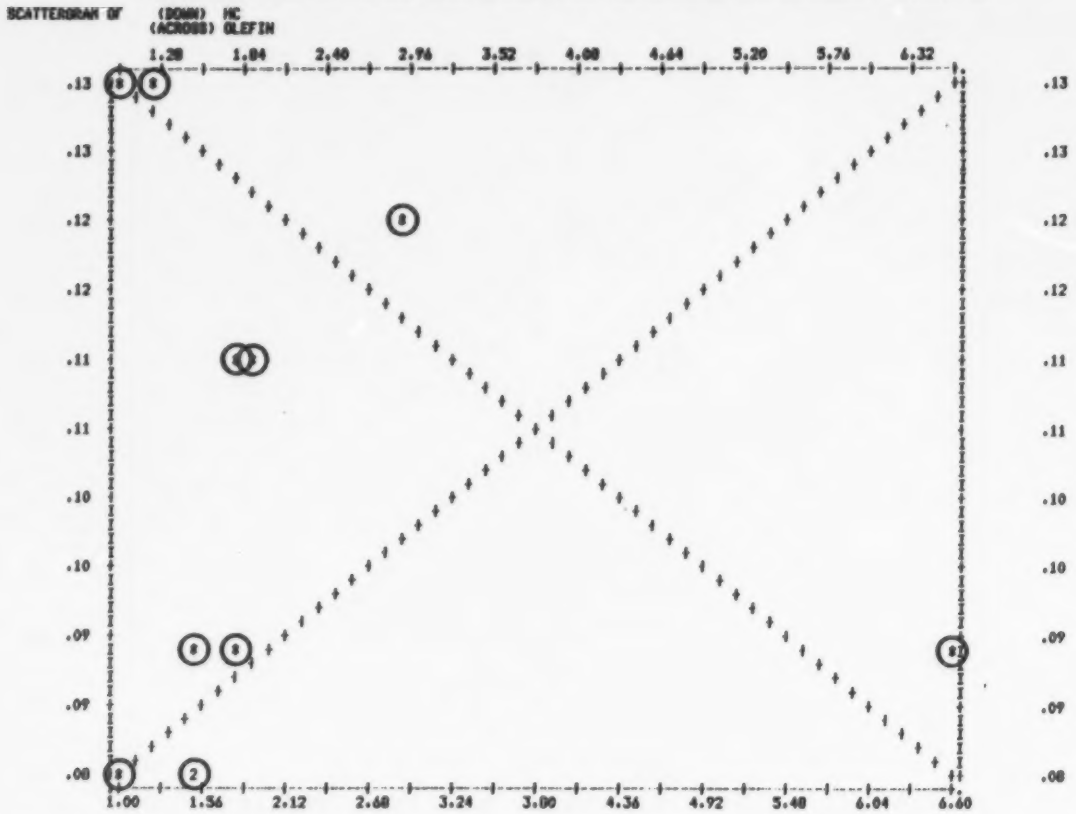
SCATTERGRAM OF (DOWN) HC
(ACROSS) CETANE

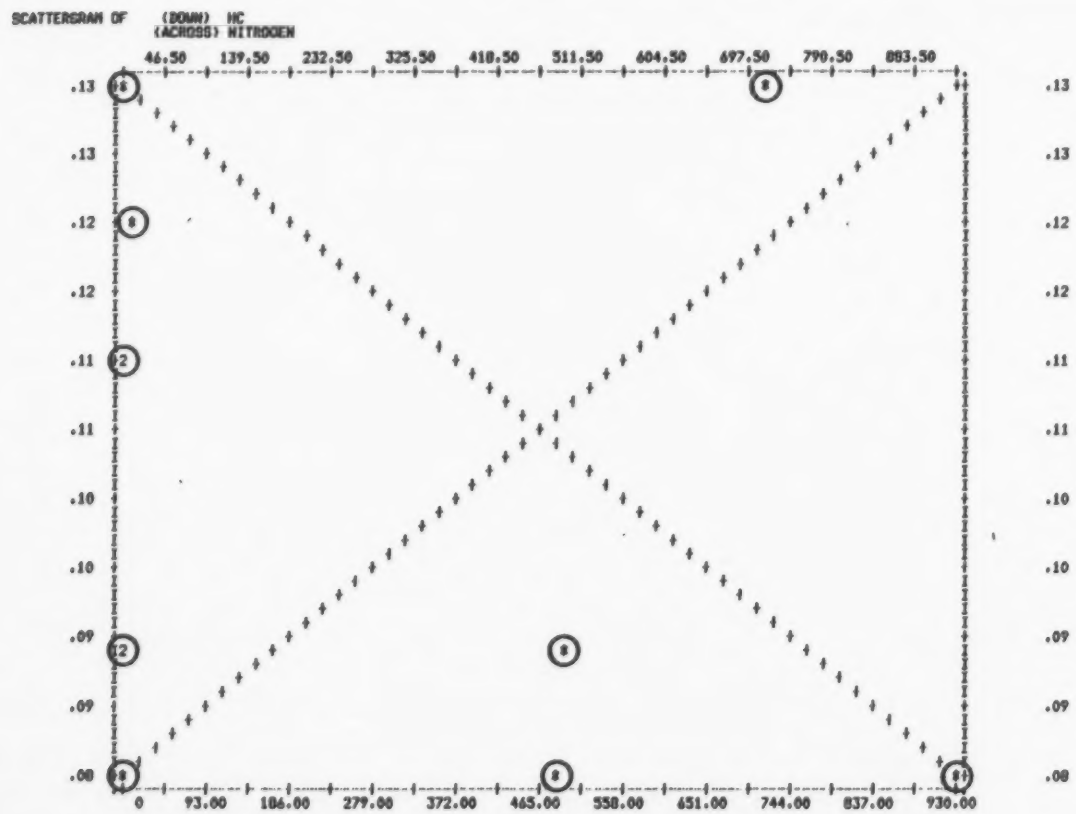


SCATTERGRAM OF (DOWN) HC
(ACROSS) AROMATIC

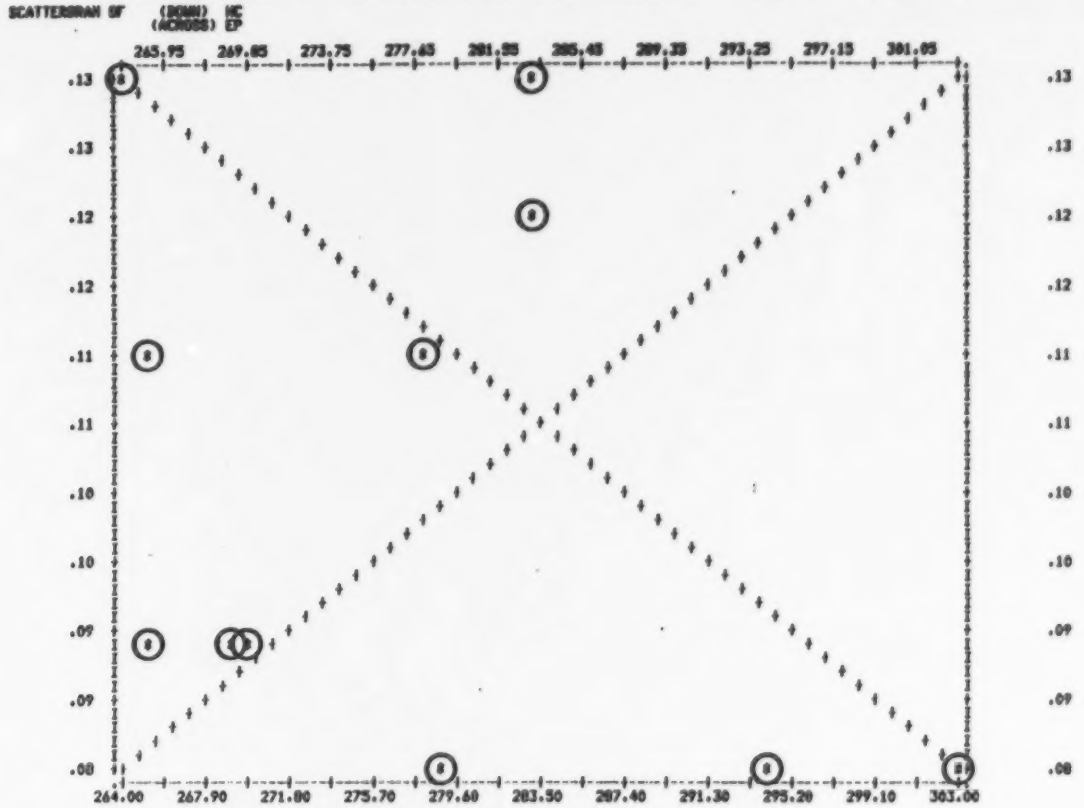


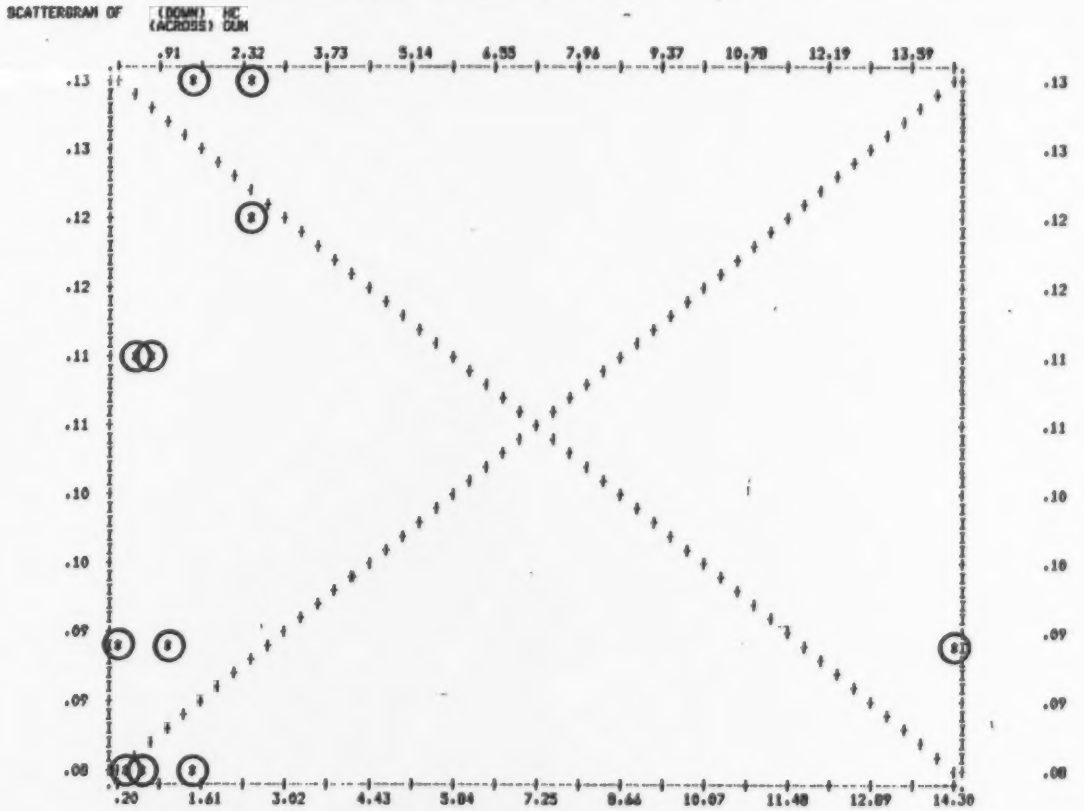
SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)





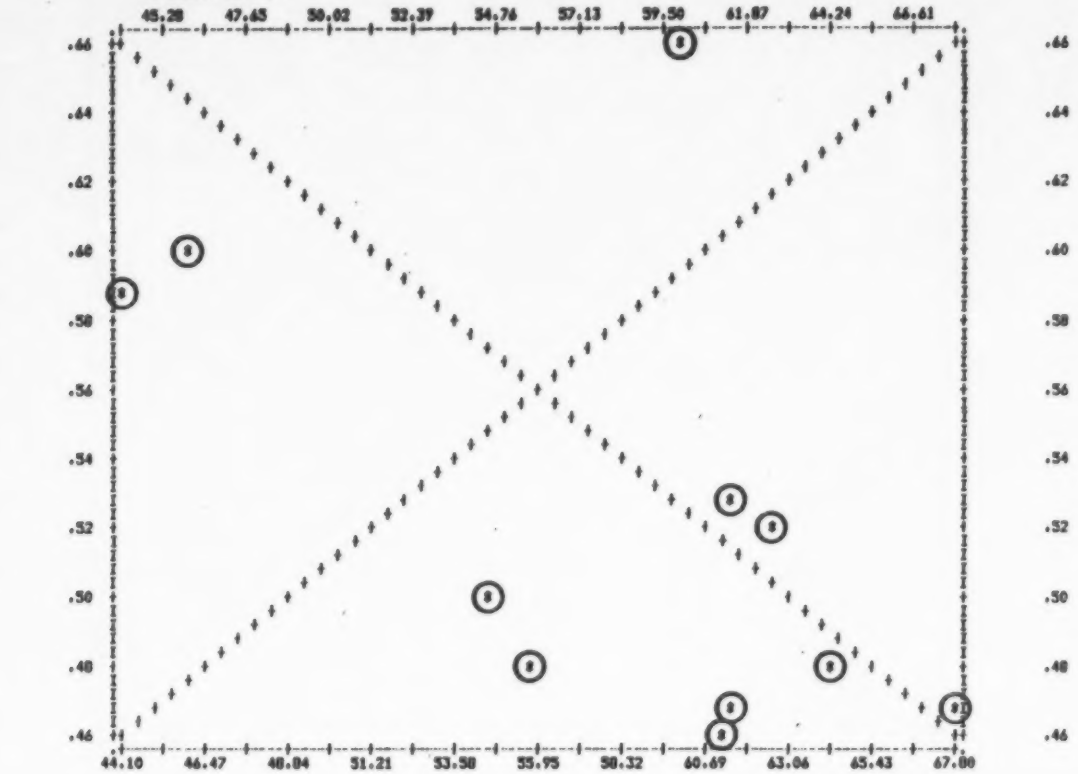
SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)



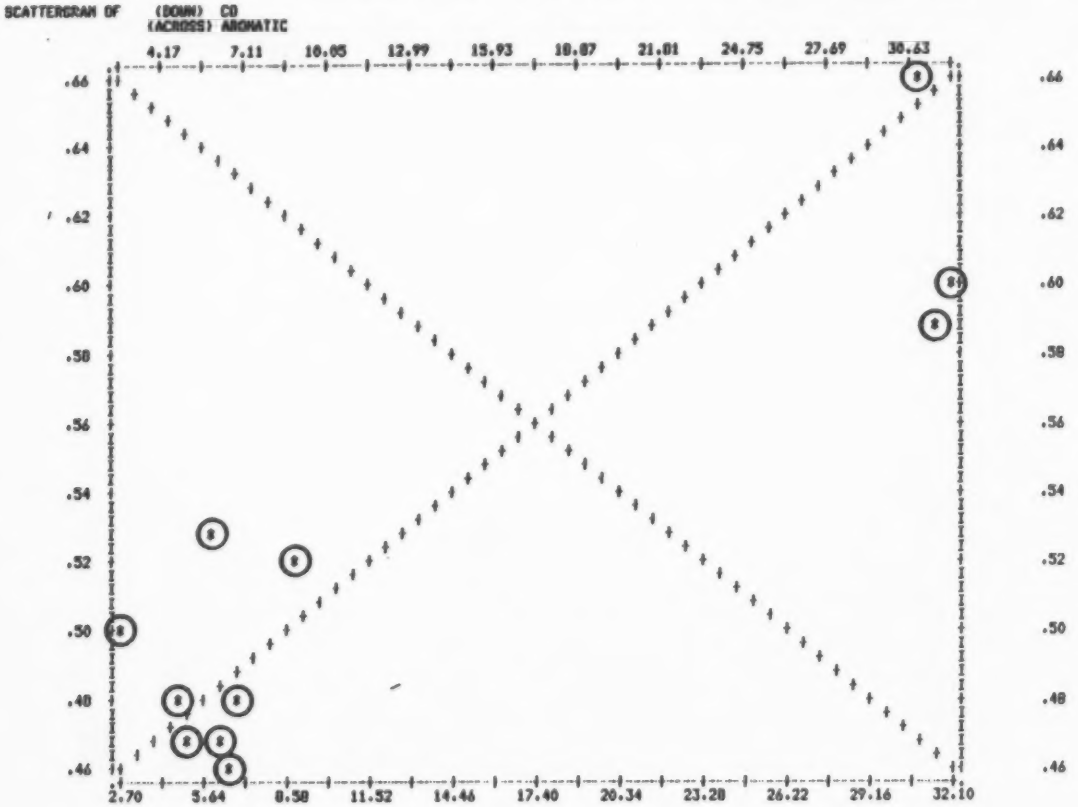


SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)

SCATTERGRAM OF (DOWN) CO
(ACROSS) CETANE

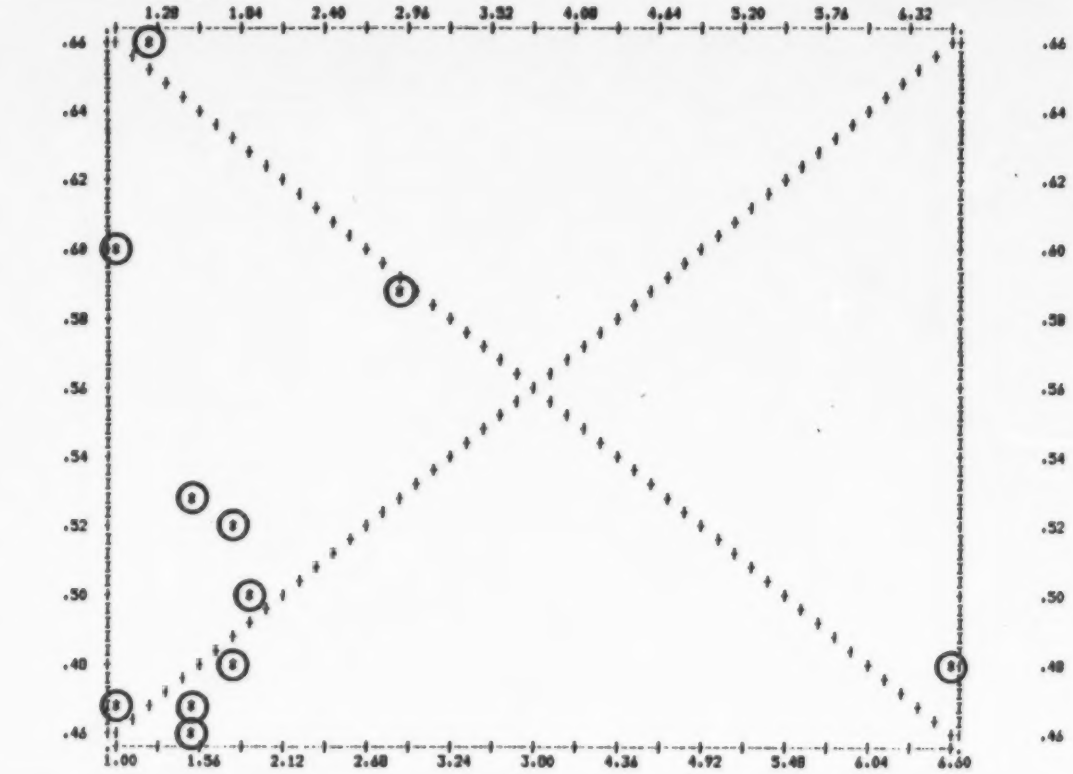


SCATTERGRAM OF (DOWN) CO
(ACROSS) AROMATIC

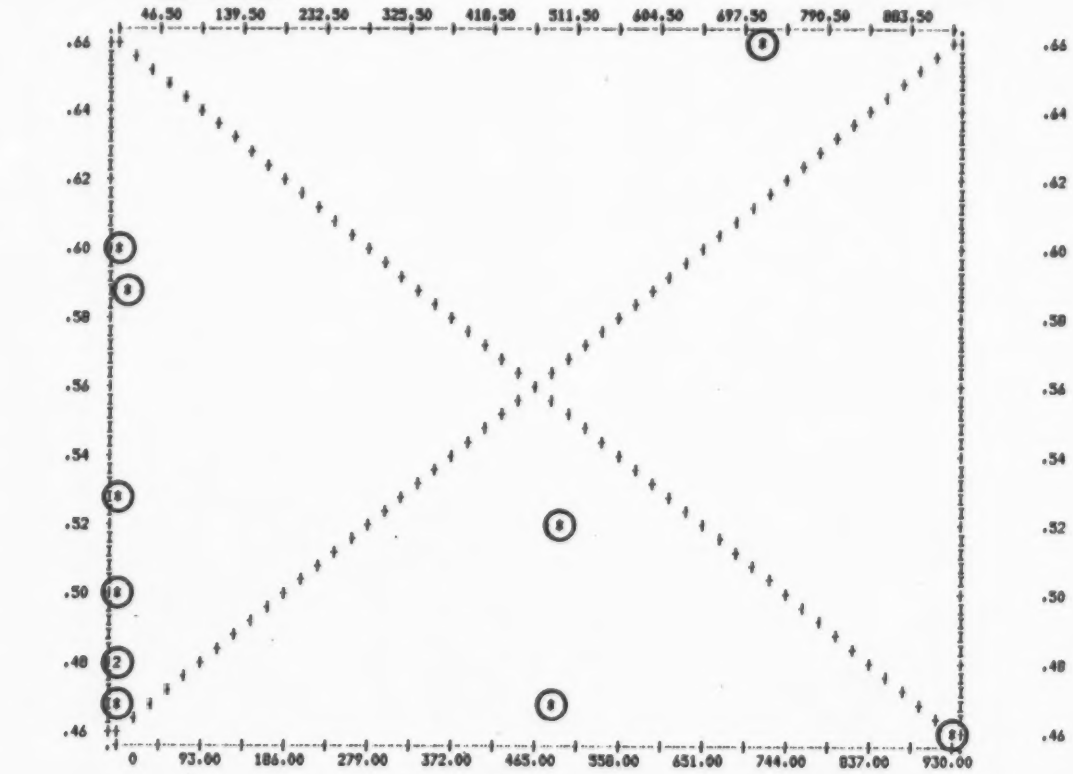


SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)

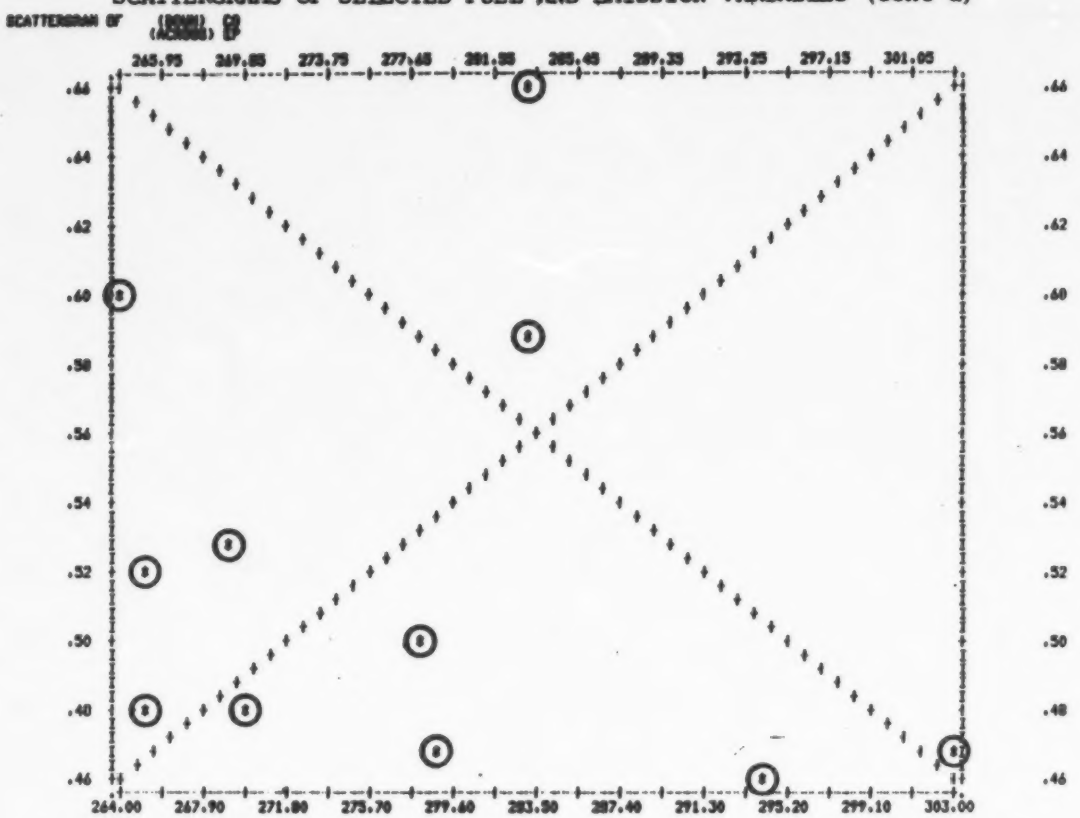
SCATTERGRAM OF (DOWN) CO
(ACROSS) OLEFIN

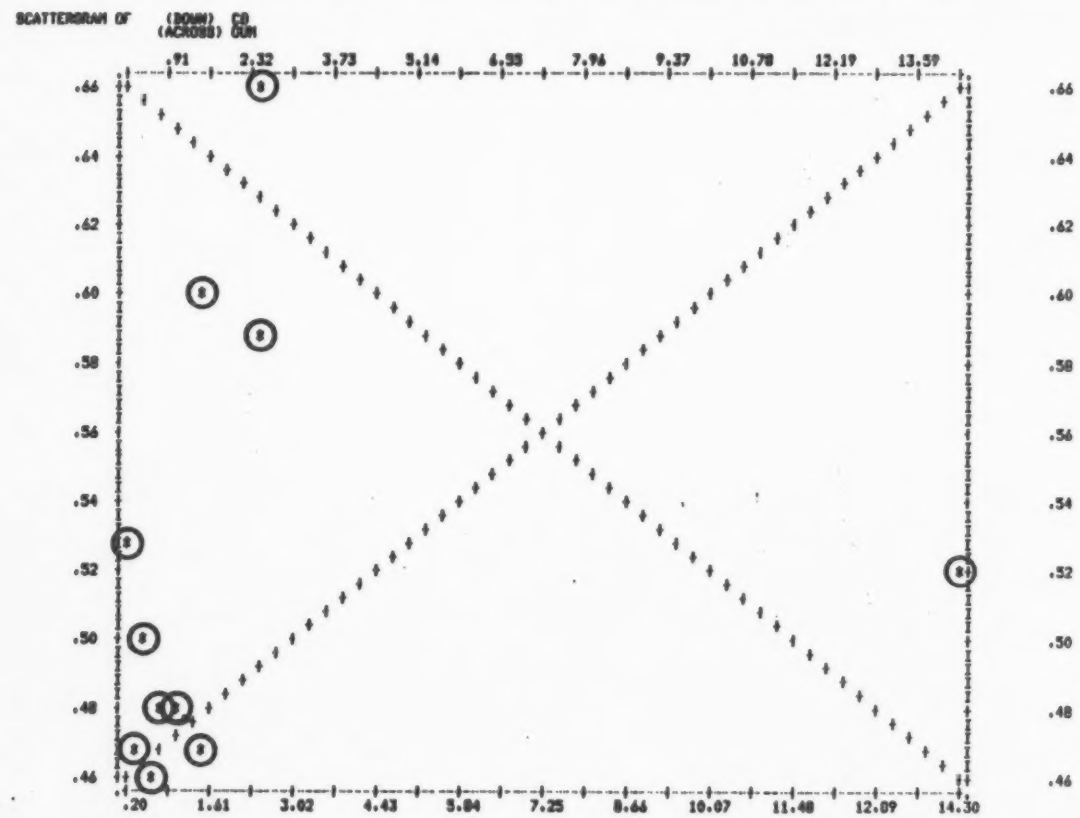


SCATTERGRAM OF (DOWN) CO
(ACROSS) NITROGEN

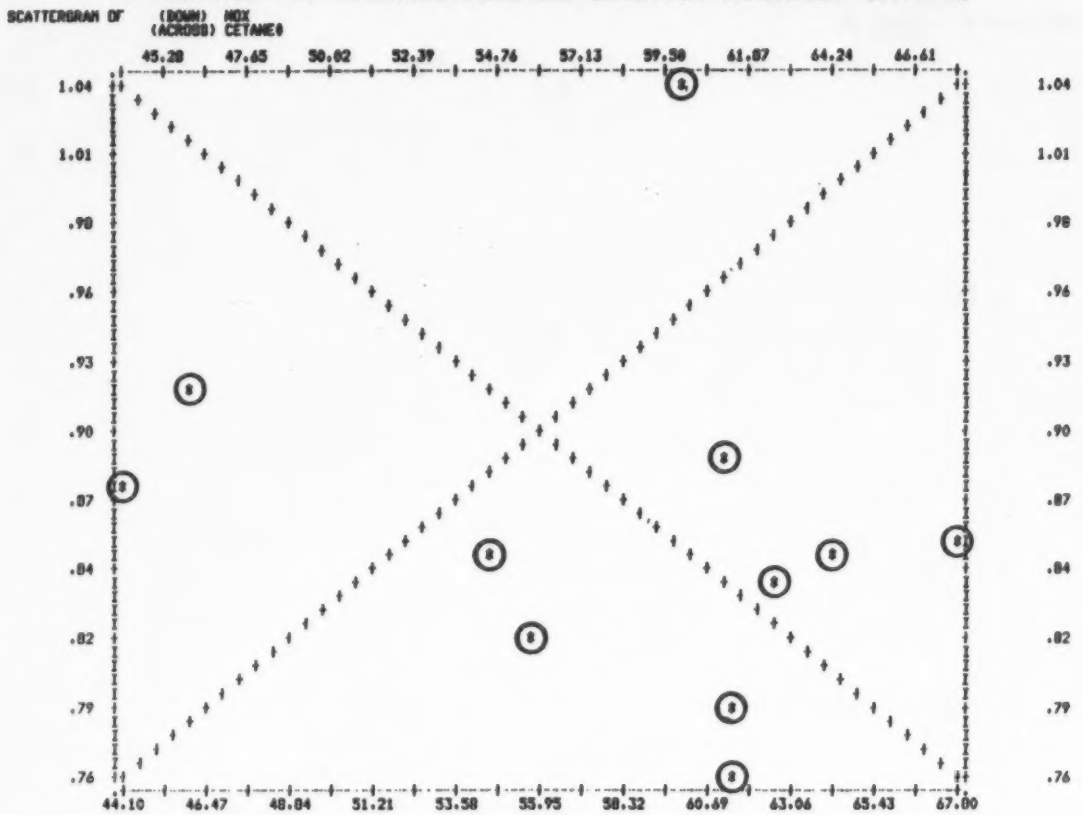


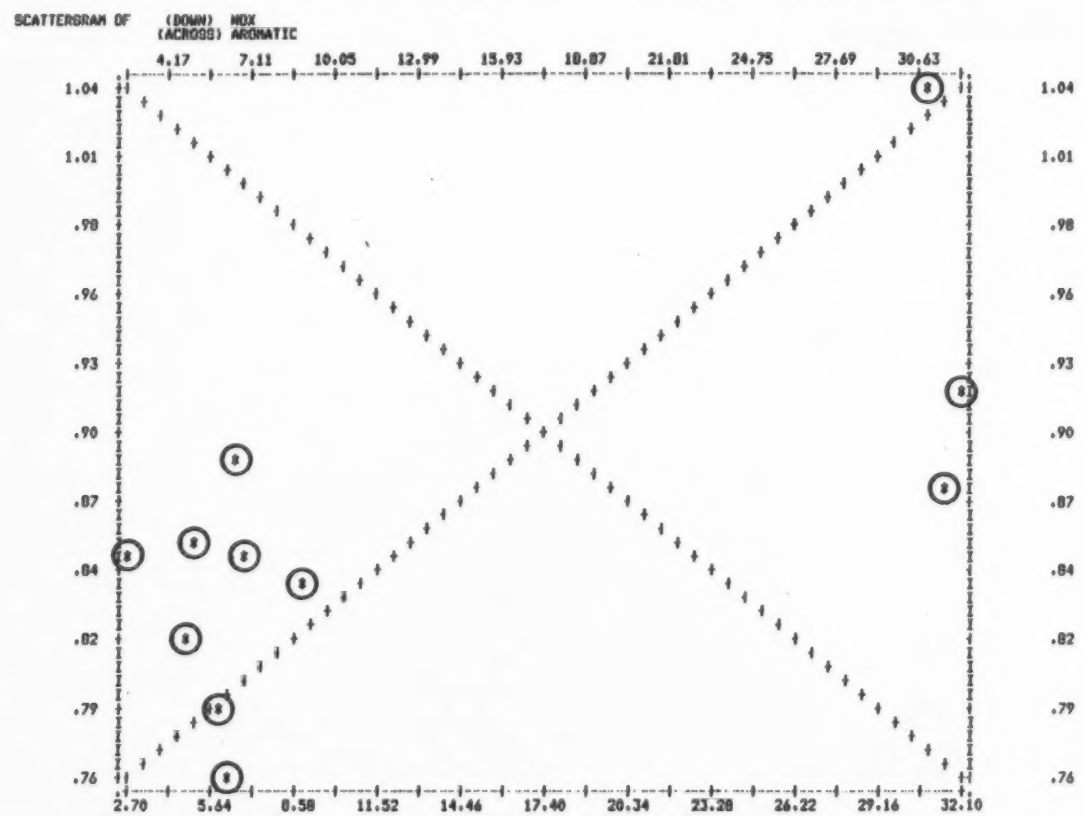
SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)



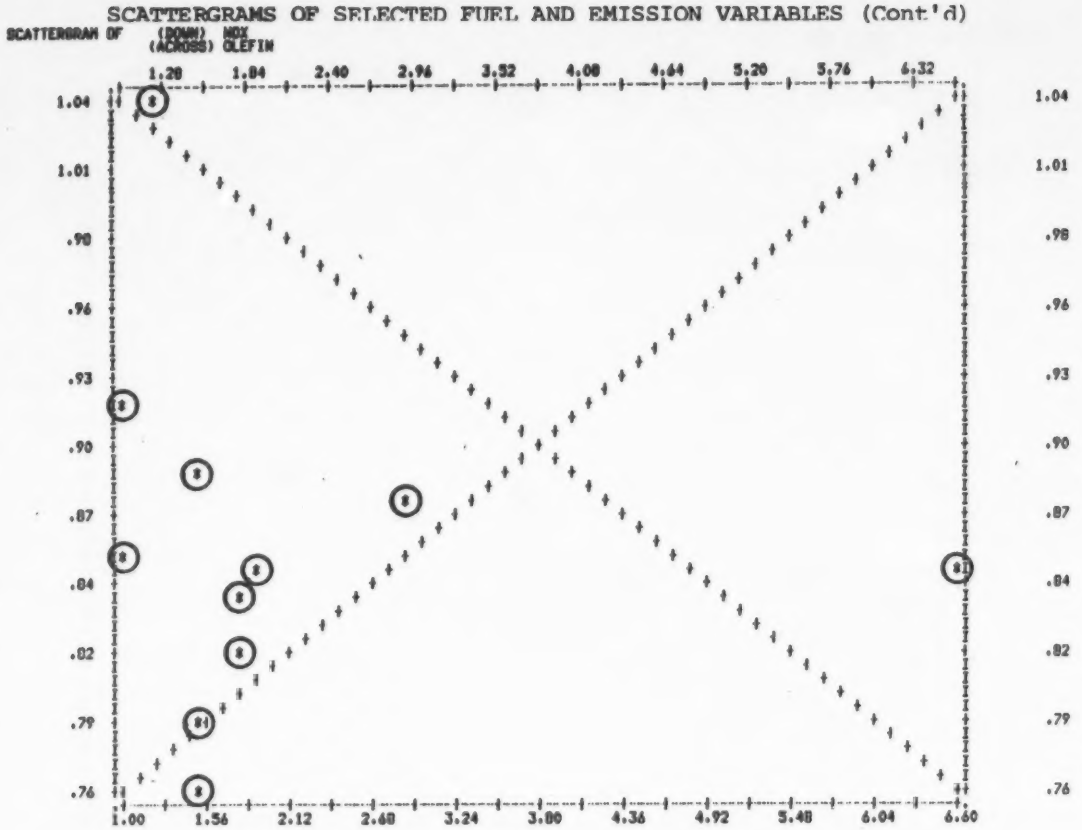


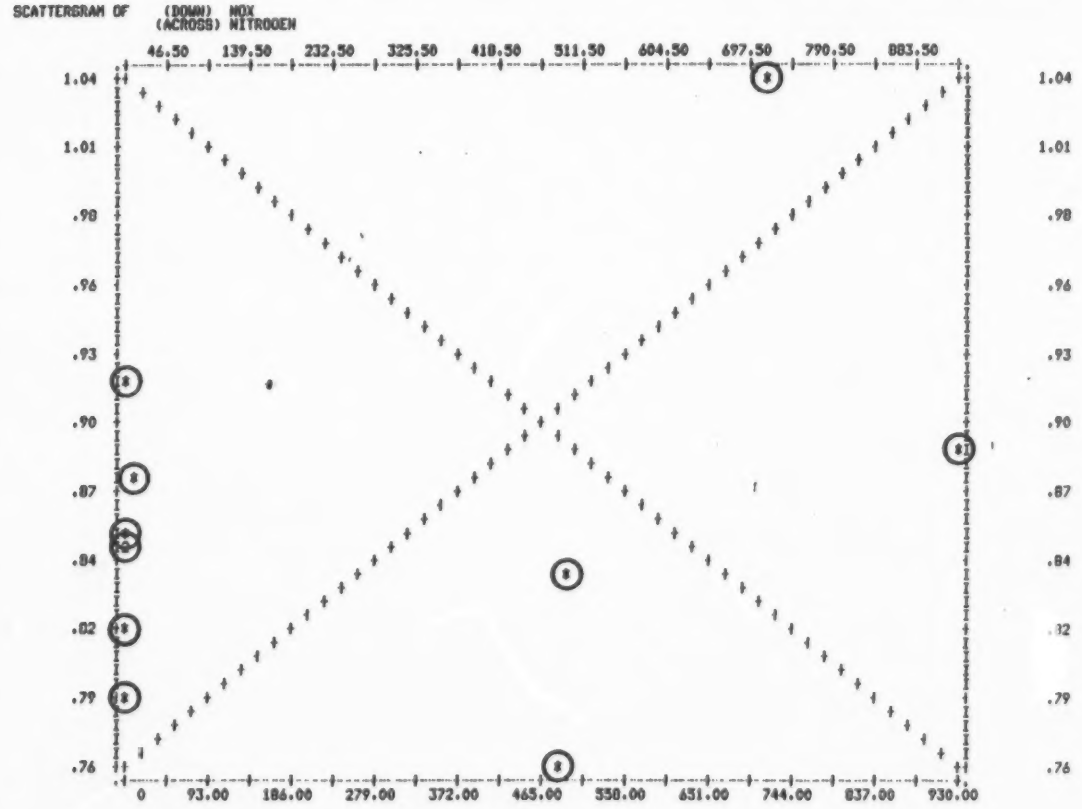
SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)



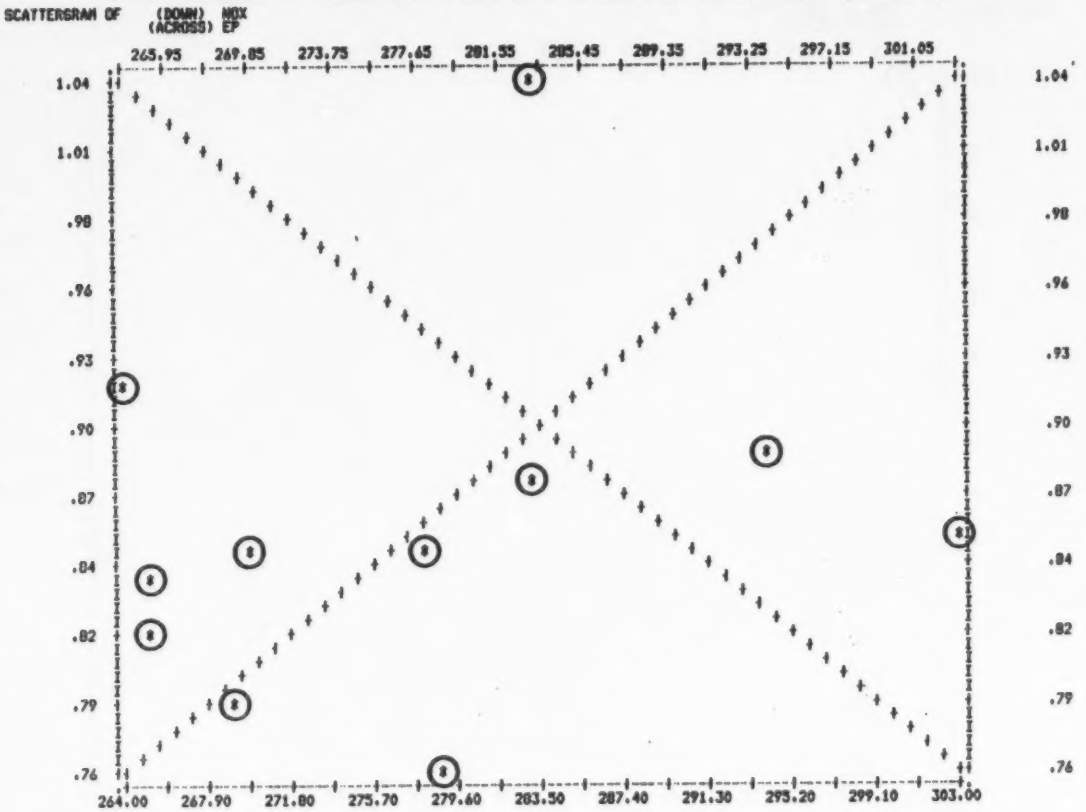


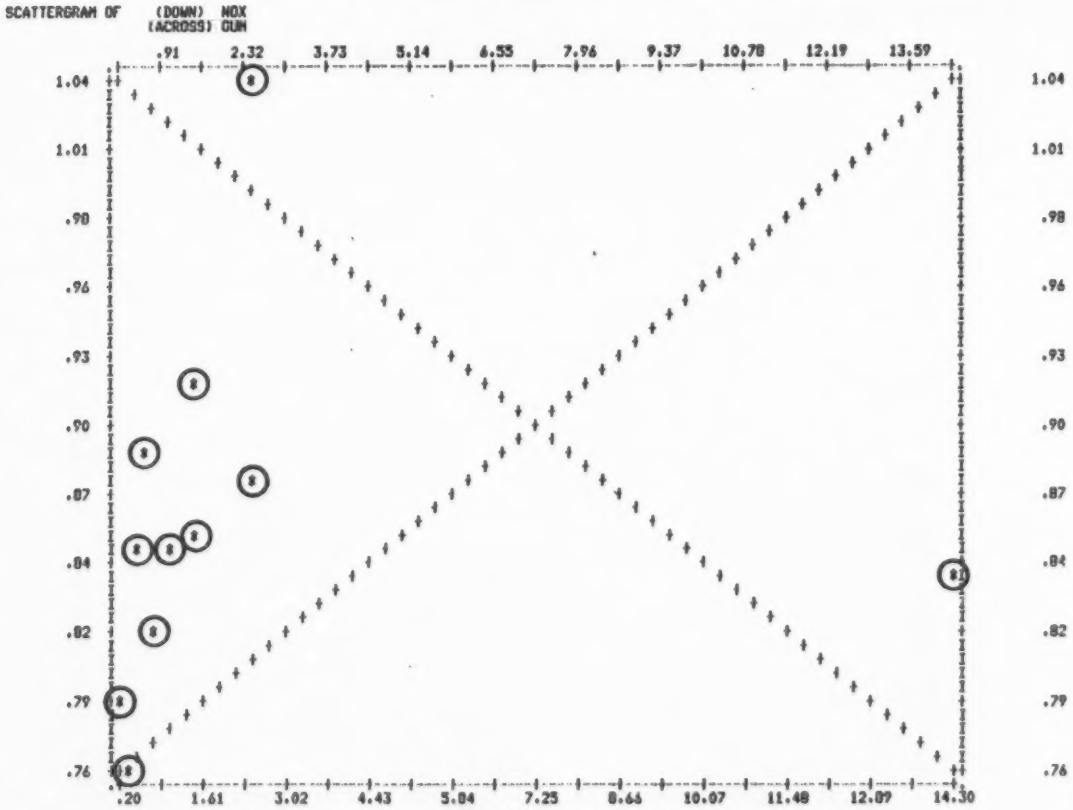
SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)



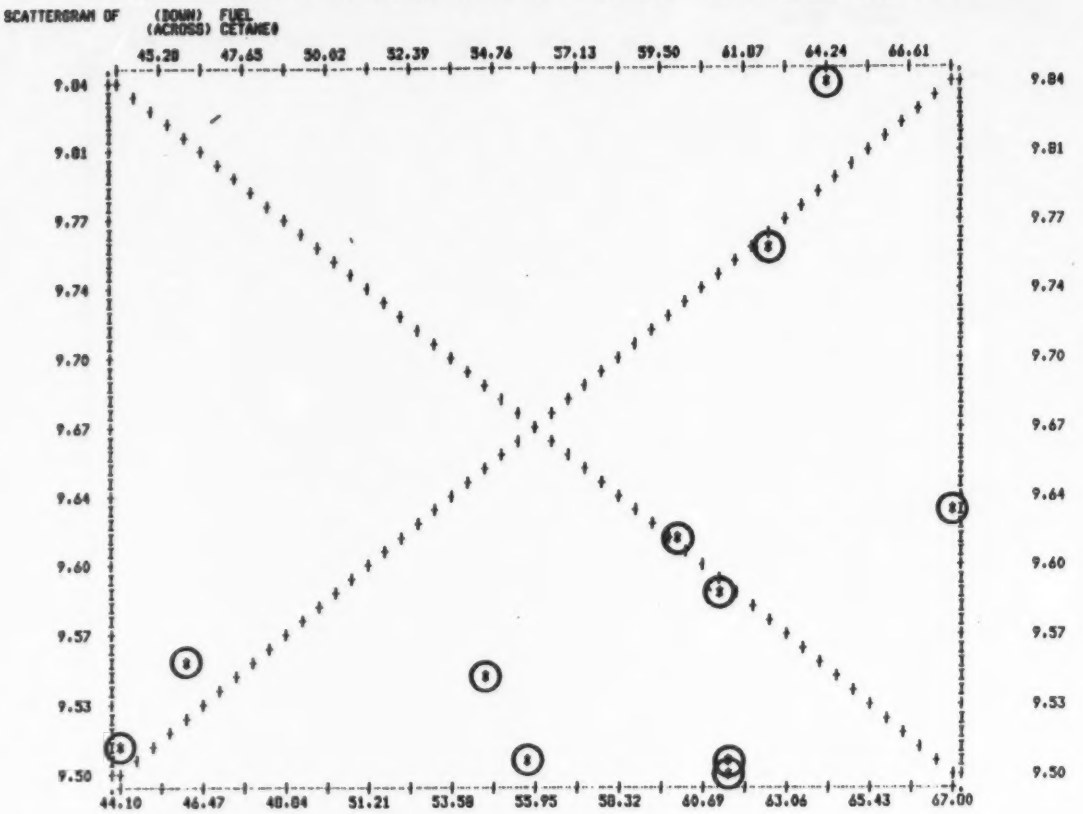


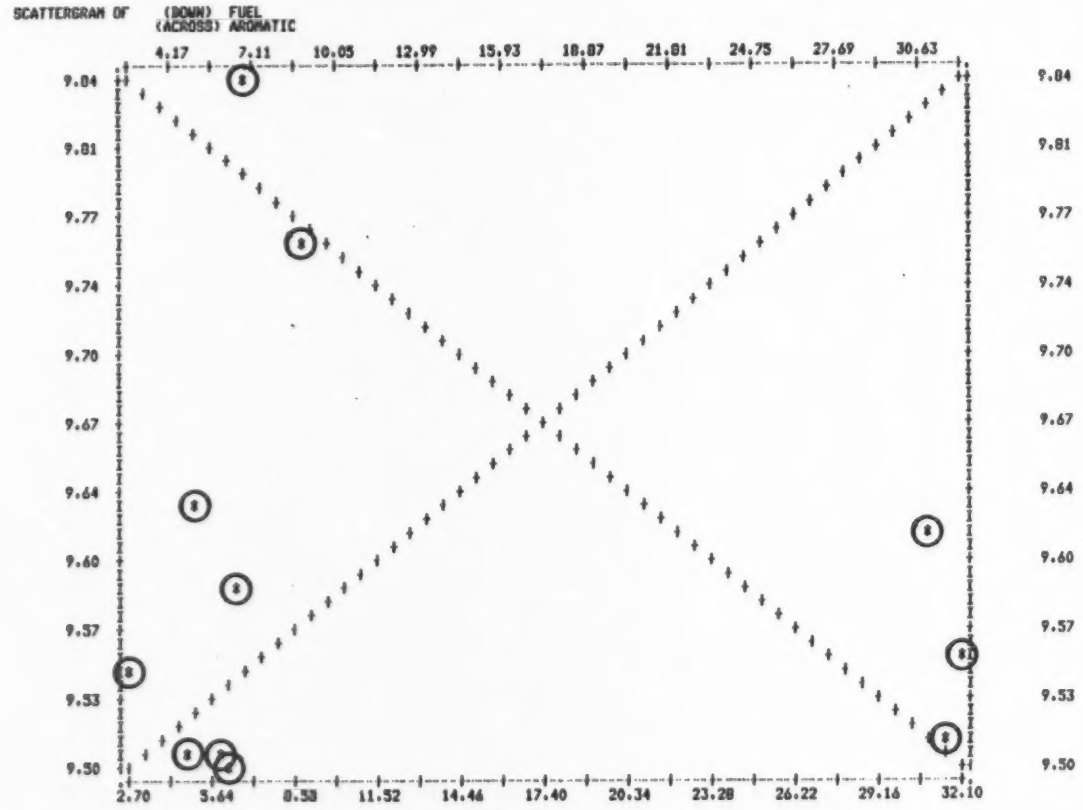
SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)

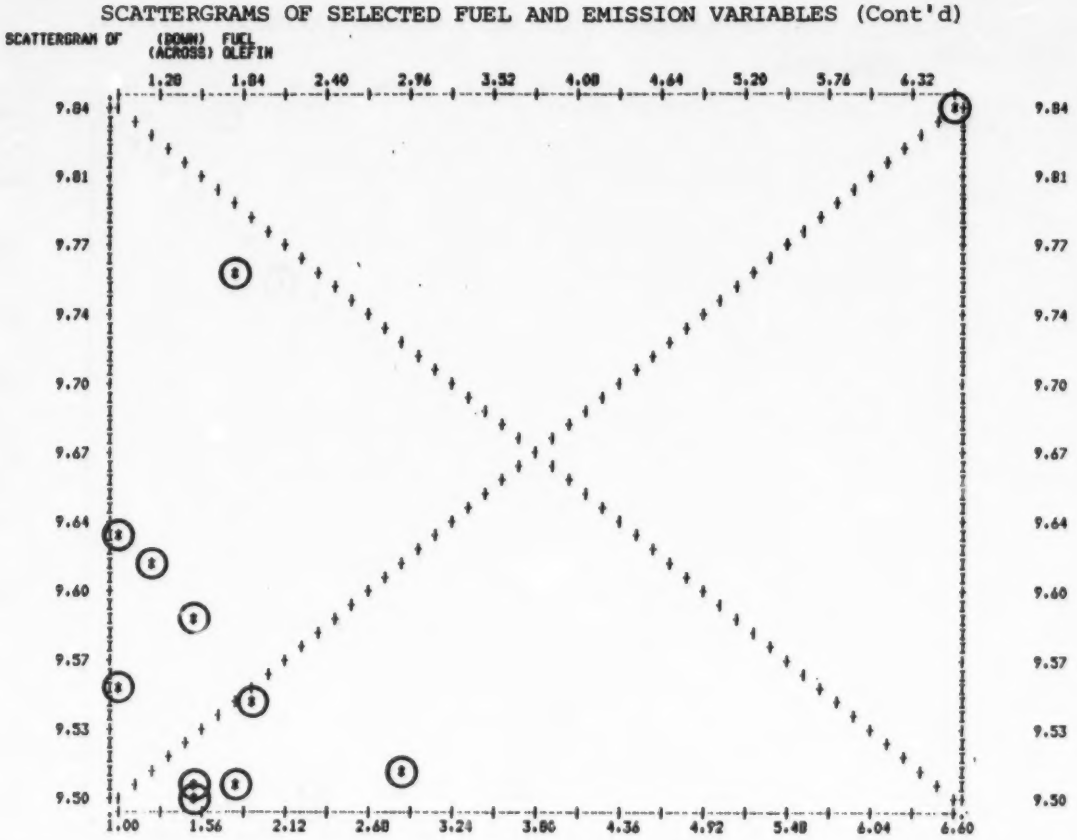


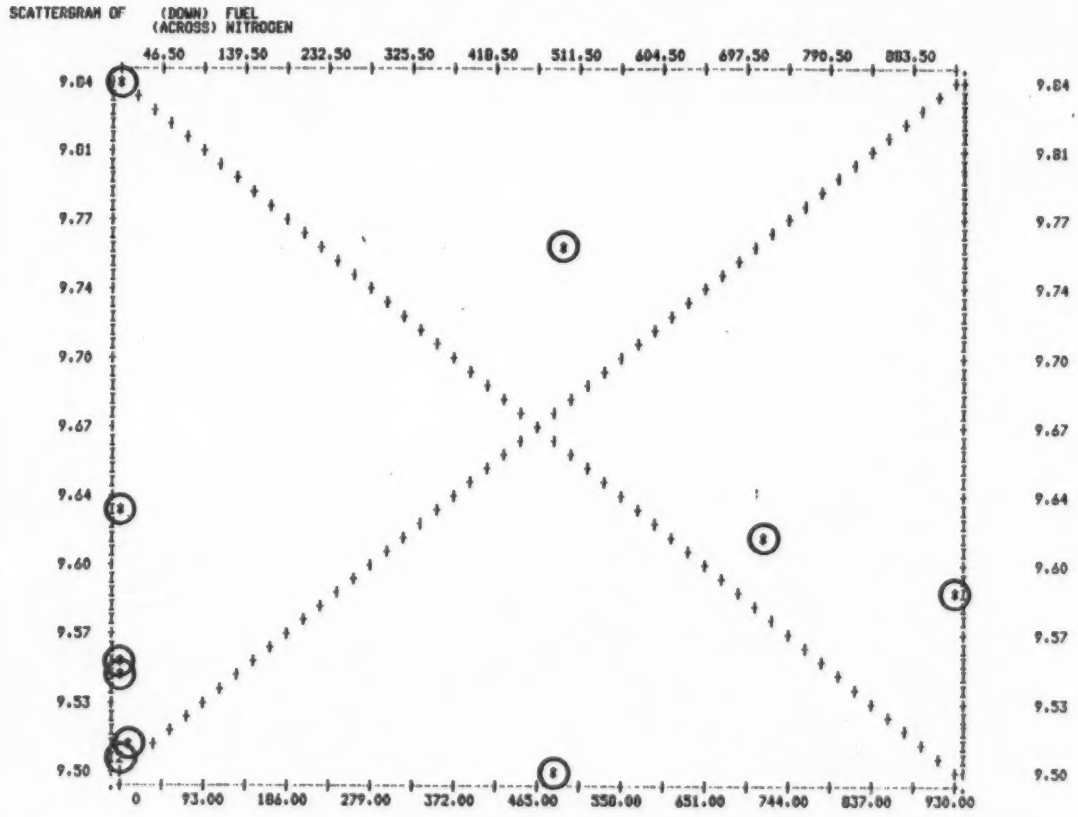


SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)

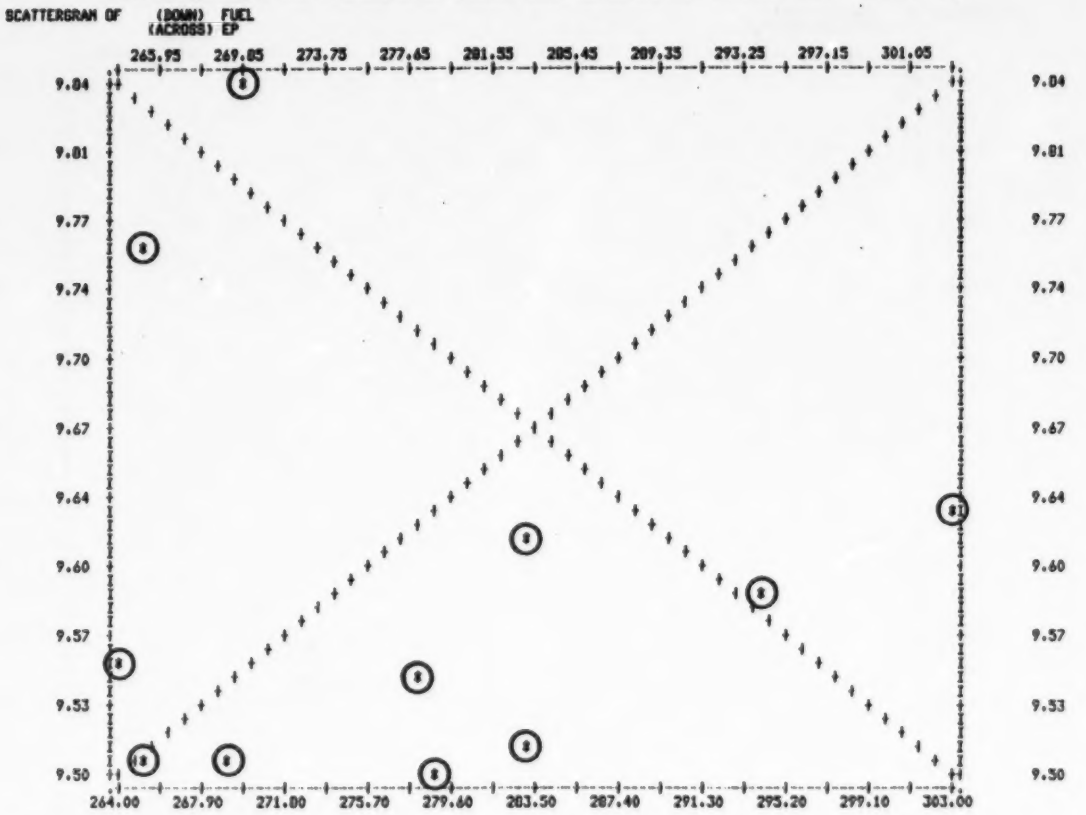


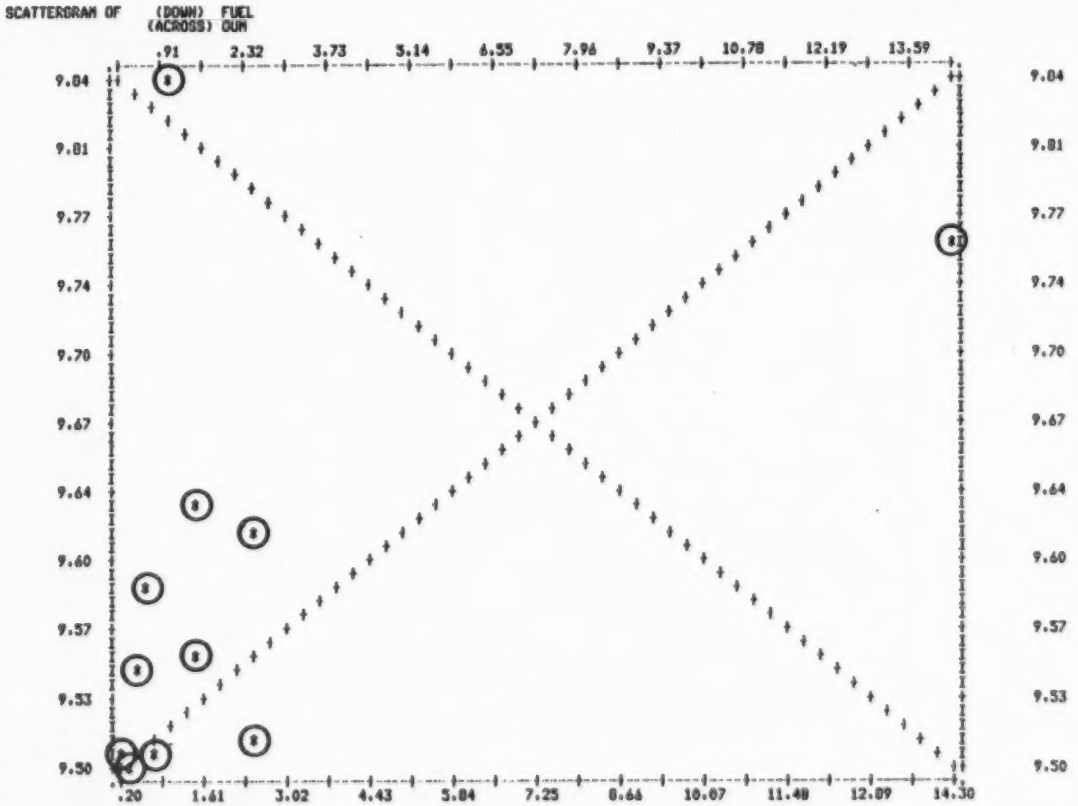


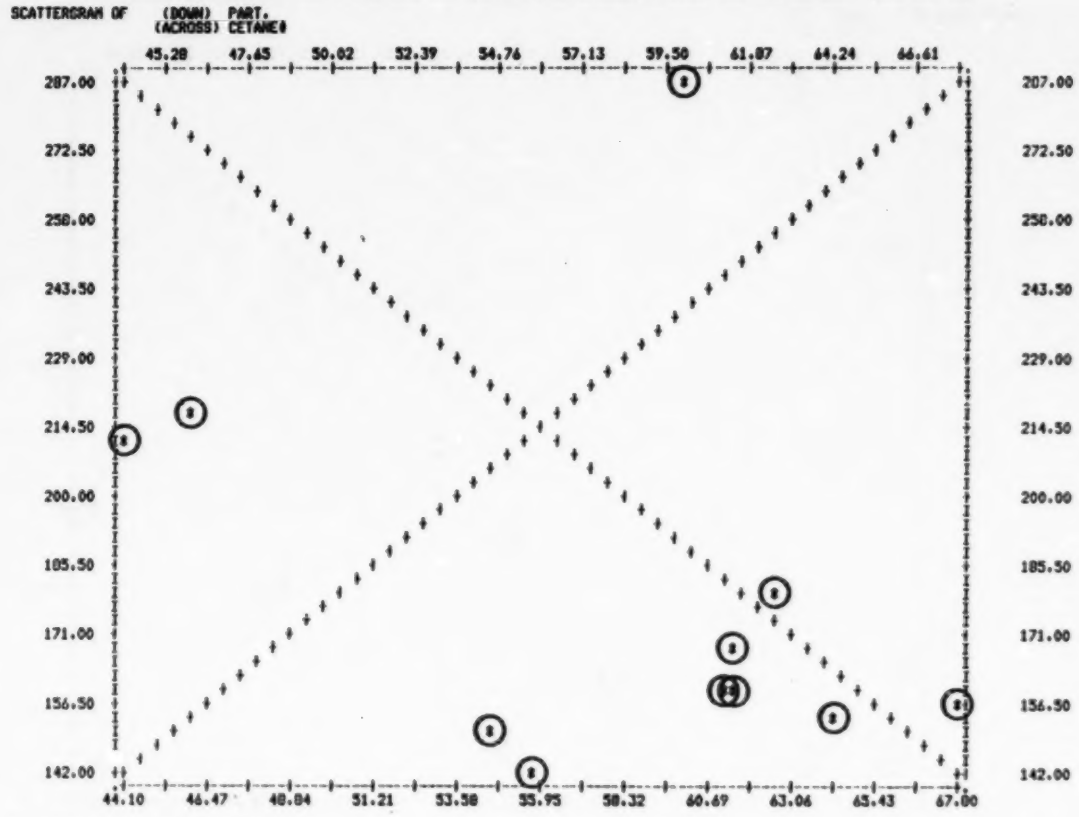

SCATTERGRAM OF (DOWN) FUEL
(ACROSS) OLEFIN
1.20 1.84 2.40 2.96 3.52 4.08 4.64 5.20 5.76 6.32
9.84
9.81
9.77
9.74
9.70
9.67
9.64
9.60
9.57
9.53
9.50
1.00 1.56 2.12 2.68 3.24 3.80 4.36 4.92 5.48 6.04 6.60

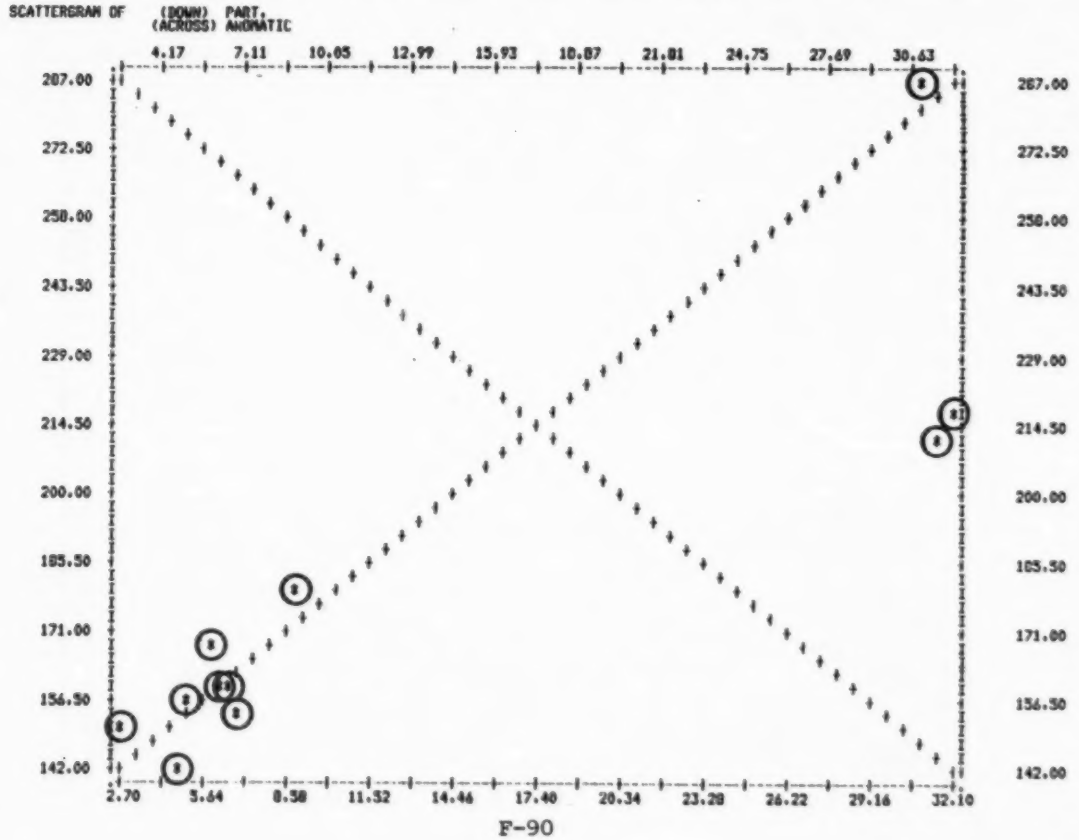

SCATTERGRAM OF (DOWN) FUEL
(ACROSS) NITROGEN
46.50 139.50 232.50 325.50 418.50 511.50 604.50 697.50 790.50 883.50
9.84
9.81
9.77
9.74
9.70
9.67
9.64
9.60
9.57
9.53
9.50
0 93.00 186.00 279.00 372.00 465.00 558.00 651.00 744.00 837.00 930.00

SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)

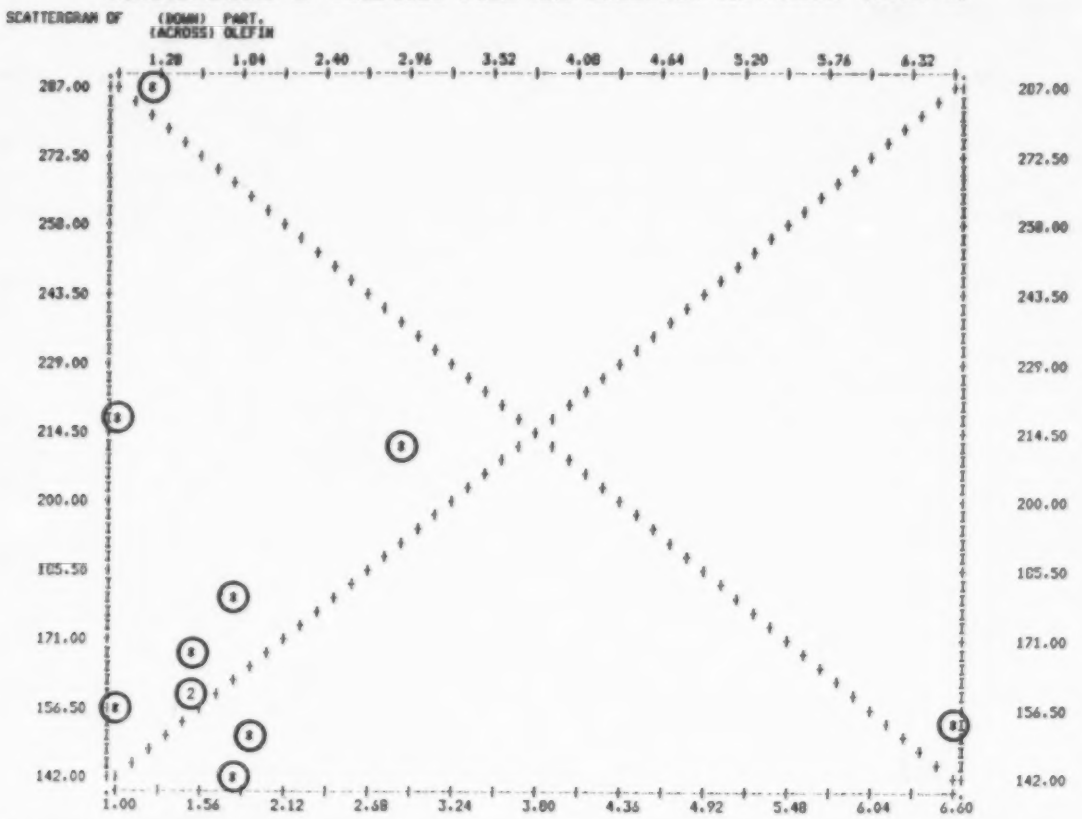


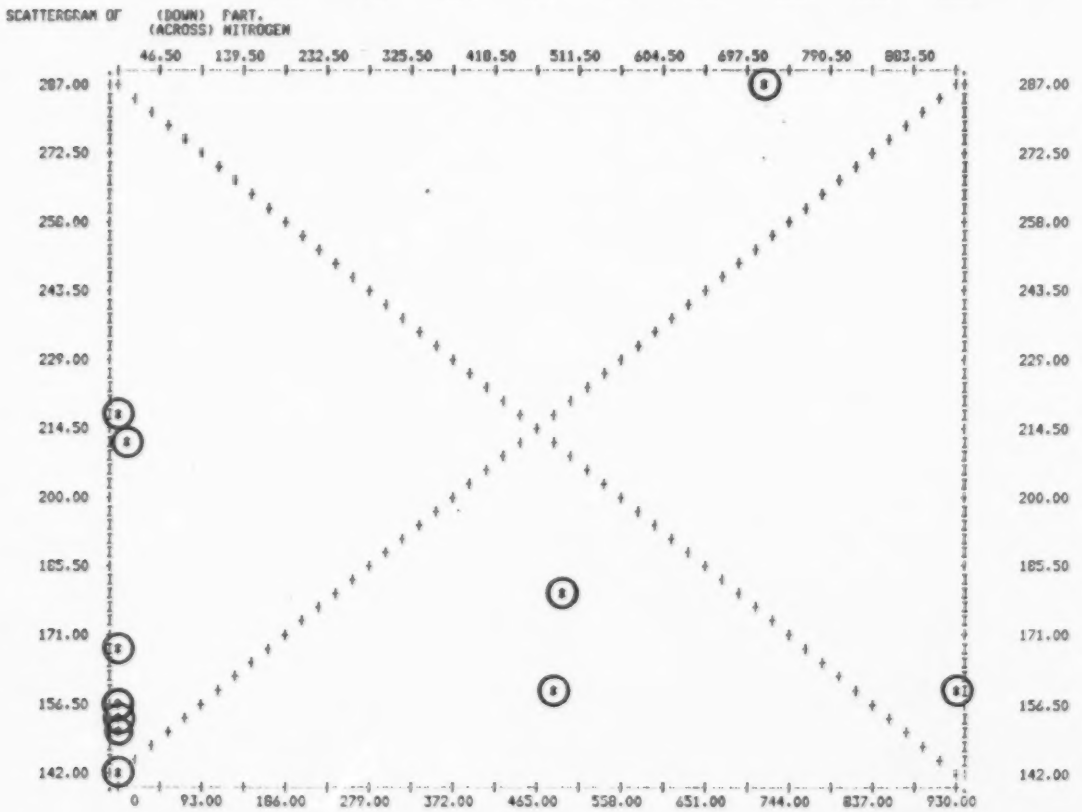


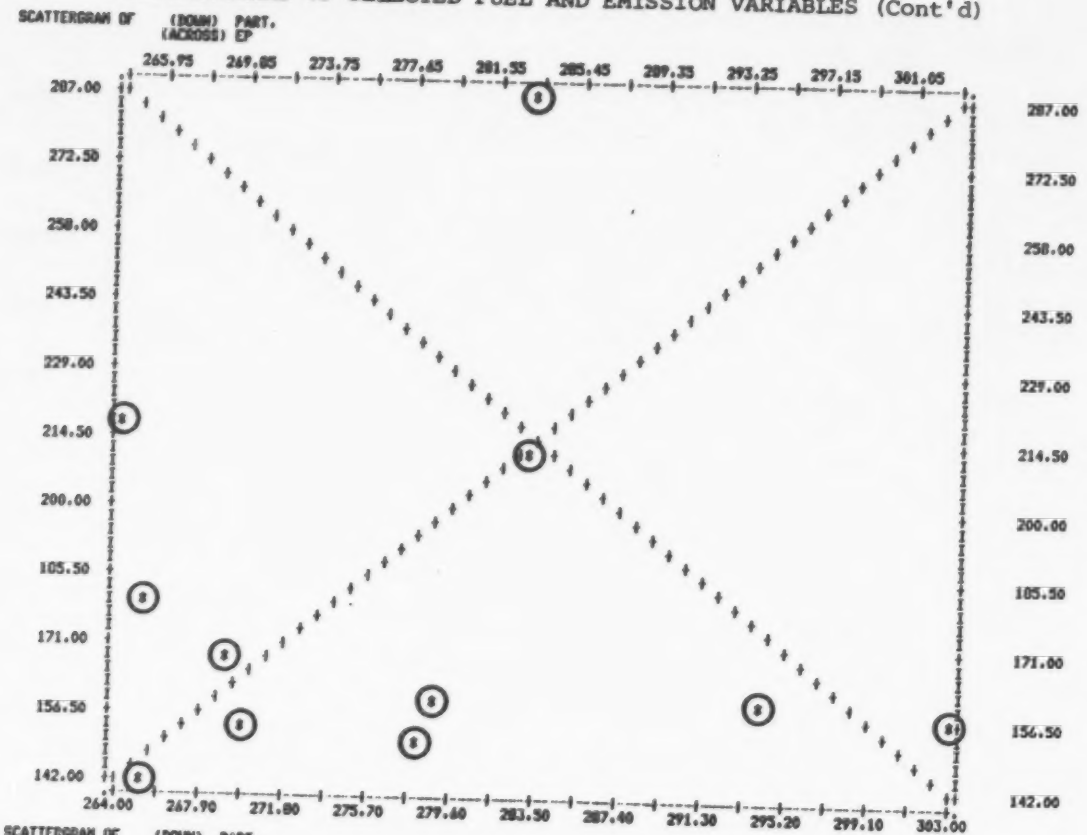

SCATTERGRAM OF (DOWN) PART.
(ACROSS) CETANE
45.28 47.45 50.02 52.39 54.76 57.13 59.50 61.87 64.24 66.61
287.00 272.50 258.00 243.50 229.00 214.50 200.00 185.50 171.00 156.50 142.00
44.10 46.47 48.84 51.21 53.58 55.95 58.32 60.69 63.06 65.43 67.80

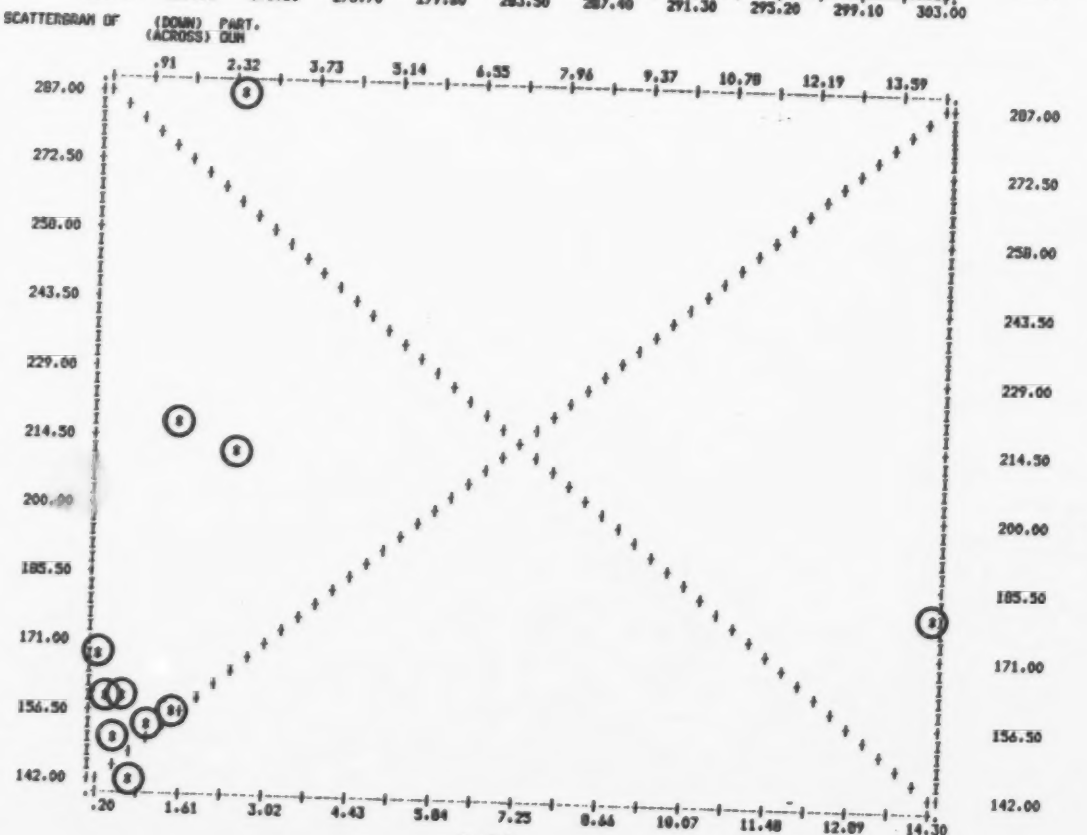

SCATTERGRAM OF (DOWN) PART.
(ACROSS) AROMATIC
4.17 7.11 10.05 12.99 15.93 18.87 21.81 24.75 27.69 30.63
287.00 272.50 258.00 243.50 229.00 214.50 200.00 185.50 171.00 156.50 142.00
2.70 5.64 8.58 11.52 14.46 17.40 20.34 23.28 26.22 29.16 32.10

SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)

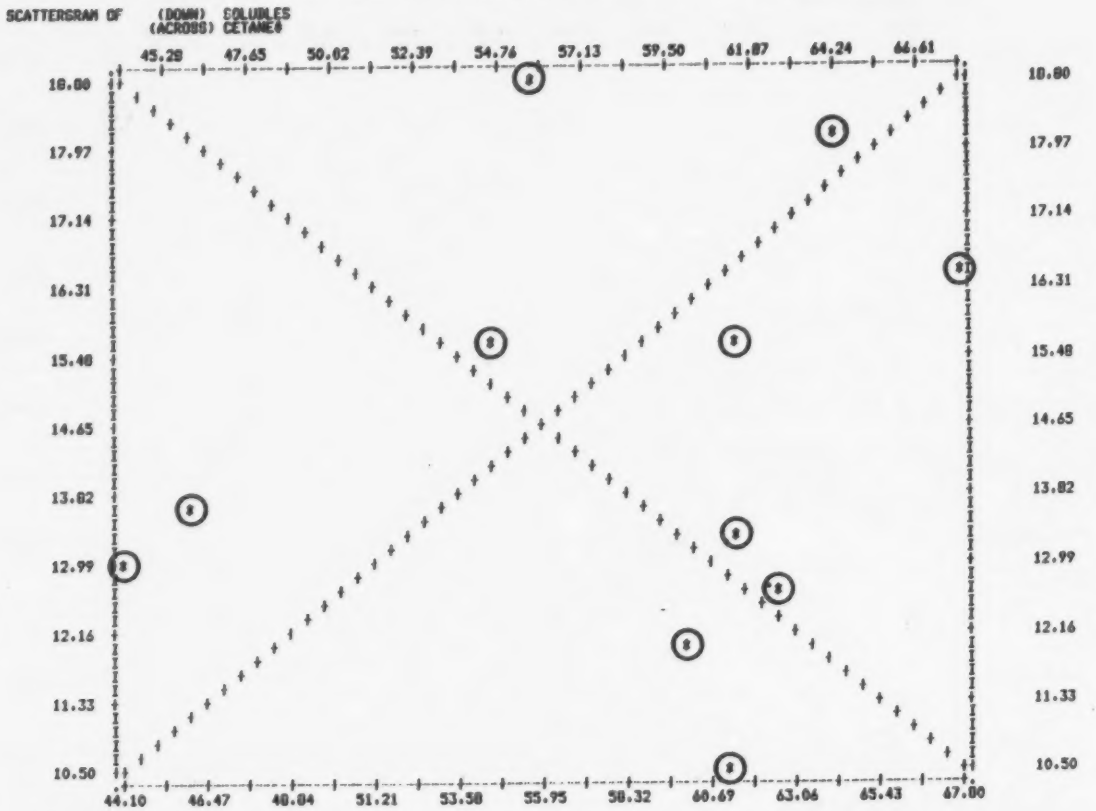


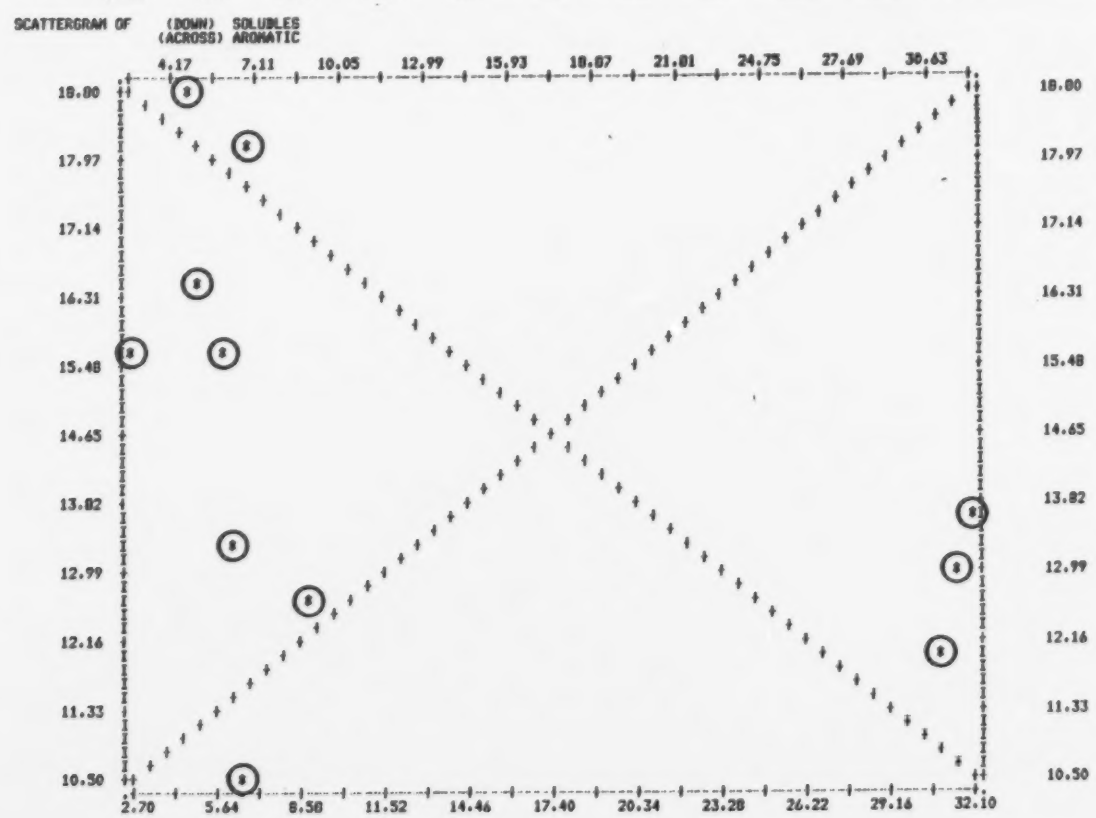



SCATTERGRAM OF (DOWN) PART. (ACROSS) EP
265.95 269.85 273.75 277.65 281.55 285.45 289.35 293.25 297.15 301.05
287.00 272.50 258.00 243.50 229.00 214.50 200.00 185.50 171.00 156.50 142.00
264.00 267.90 271.80 275.70 279.60 283.50 287.40 291.30 295.20 299.10 303.00

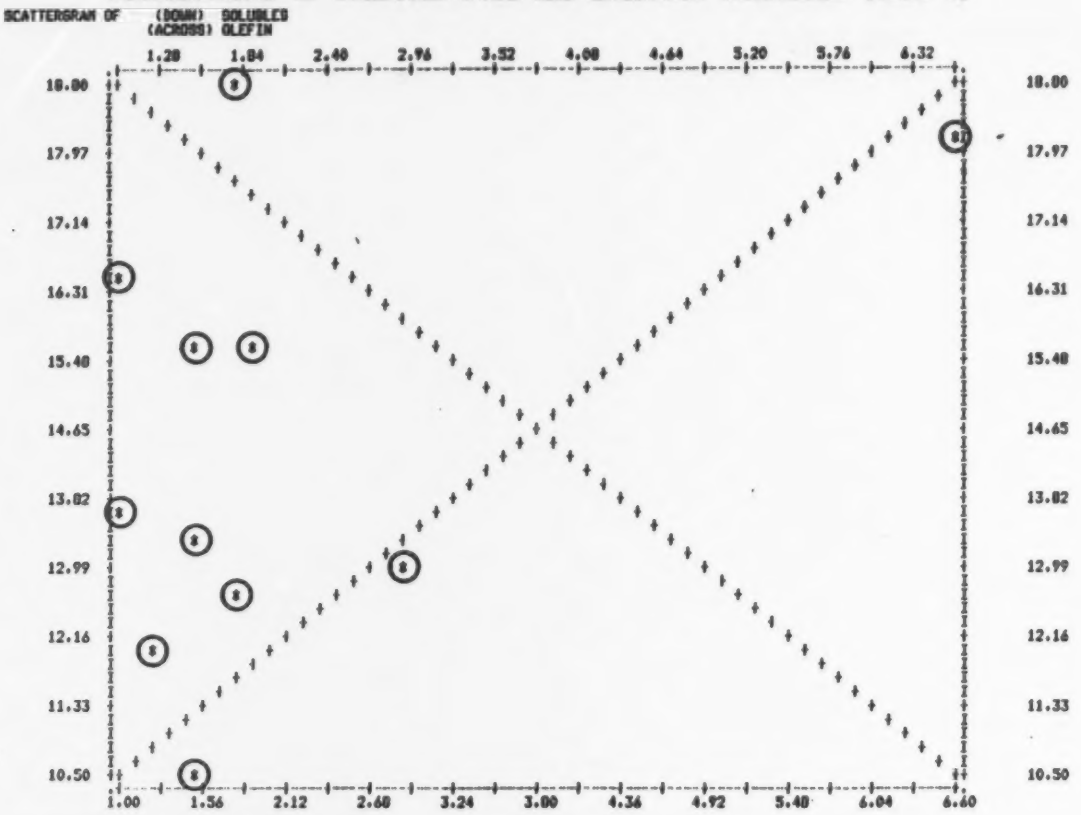

SCATTERGRAM OF (DOWN) PART. (ACROSS) DUR
.91 2.32 3.73 5.14 6.55 7.96 9.37 10.78 12.19 13.59
287.00 272.50 258.00 243.50 229.00 214.50 200.00 185.50 171.00 156.50 142.00
.20 1.61 3.02 4.43 5.84 7.25 8.66 10.07 11.48 12.89 14.30

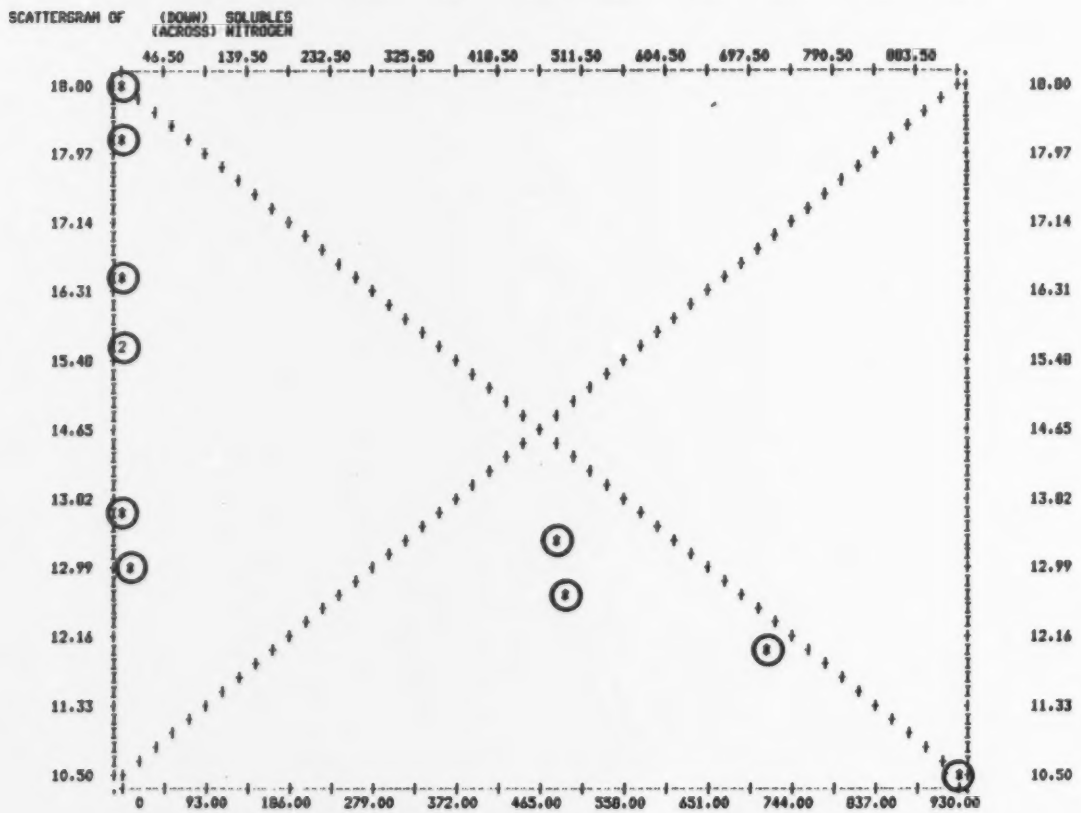
SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)

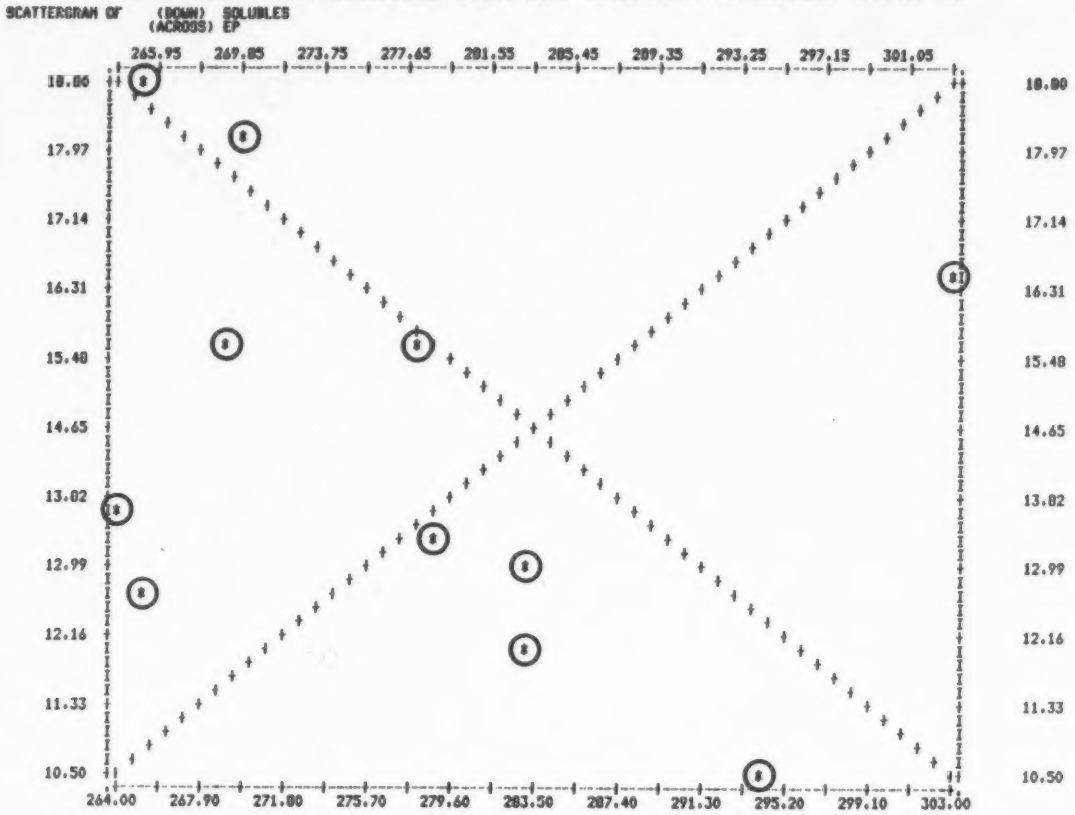


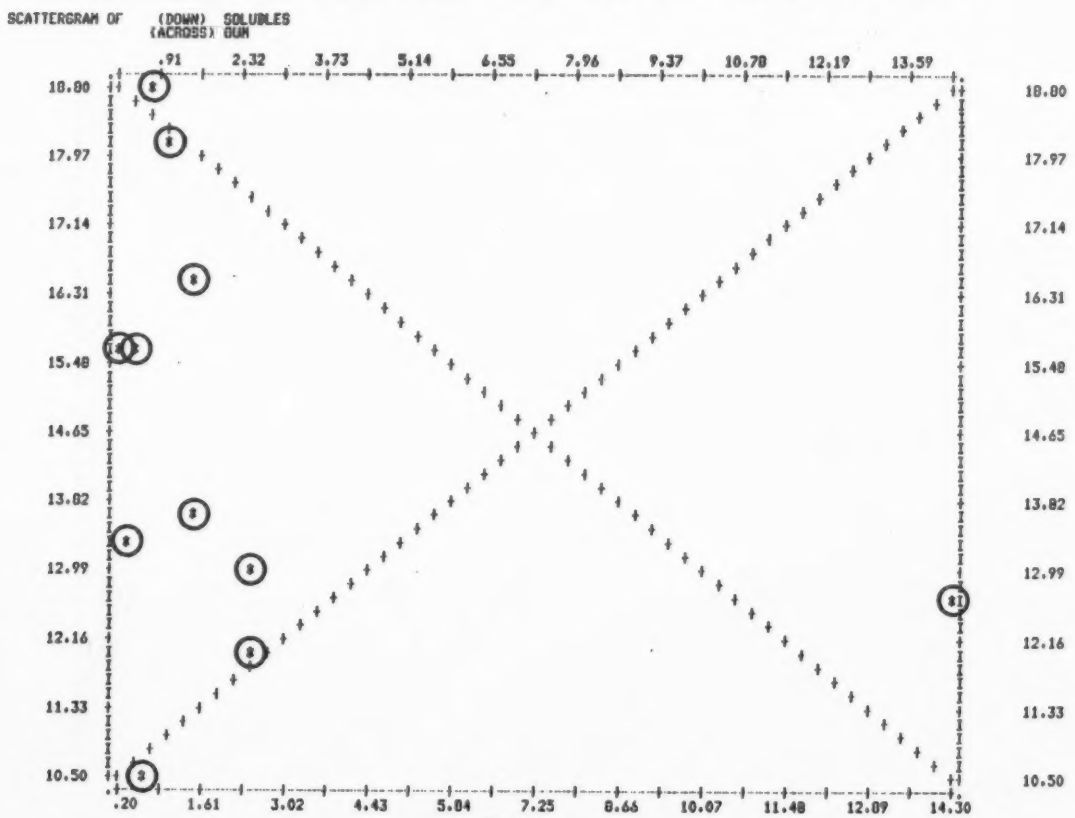


SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)



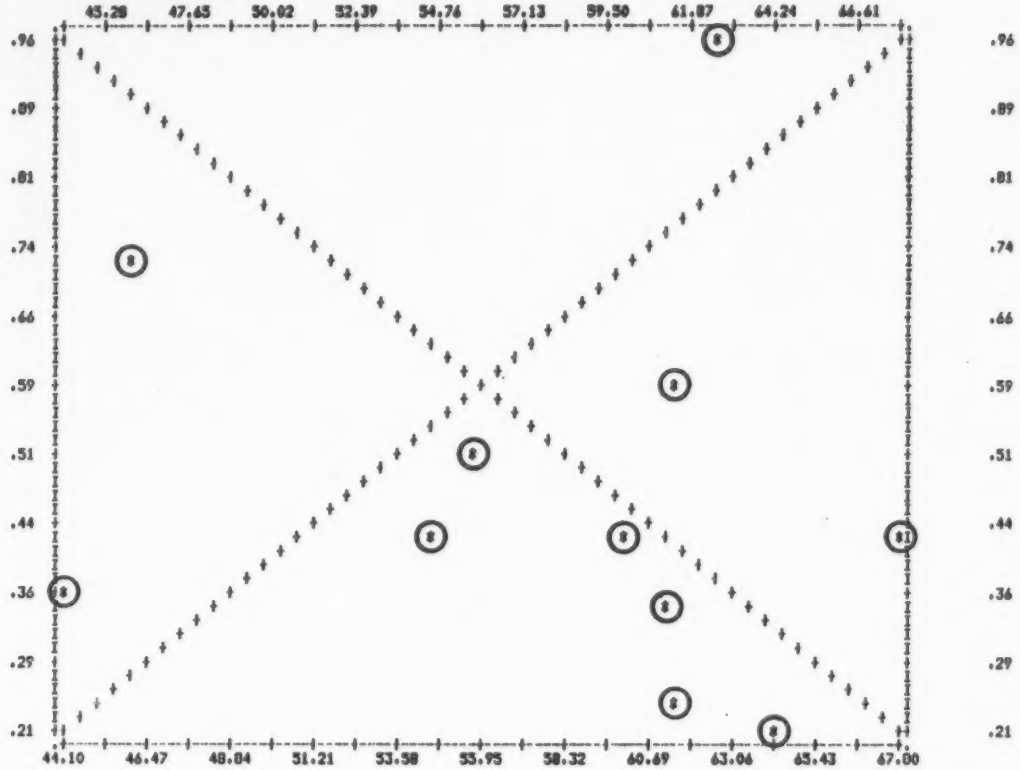



SCATTERGRAM OF (DOWN) SOLUBLES
(ACROSS) EP
265.95 269.85 273.75 277.65 281.55 285.45 289.35 293.25 297.15 301.05
18.80
17.97
17.14
16.31
15.48
14.65
13.82
12.99
12.16
11.33
10.50
264.00 267.90 271.80 275.70 279.60 283.50 287.40 291.30 295.20 299.10 303.00

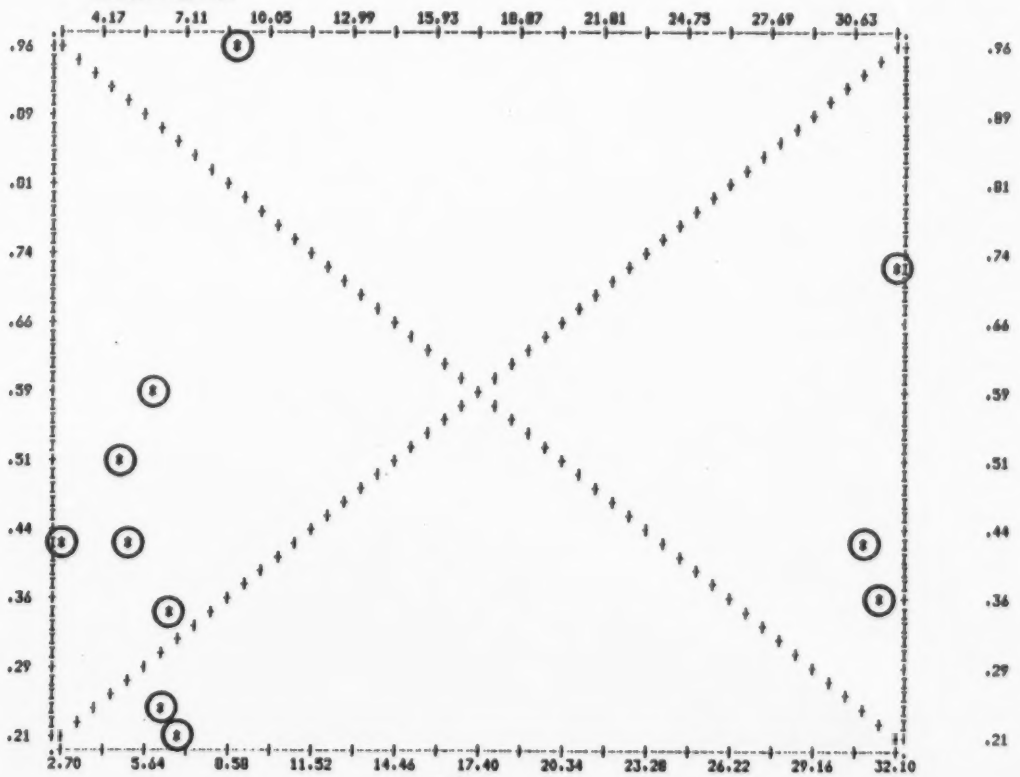

SCATTERGRAM OF (DOWN) SOLUBLES
(ACROSS) GUM
.91 2.32 3.73 5.14 6.55 7.96 9.37 10.78 12.19 13.59
18.80
17.97
17.14
16.31
15.48
14.65
13.82
12.99
12.16
11.33
10.50
.20 1.61 3.02 4.43 5.84 7.25 8.66 10.07 11.48 12.89 14.30

SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)

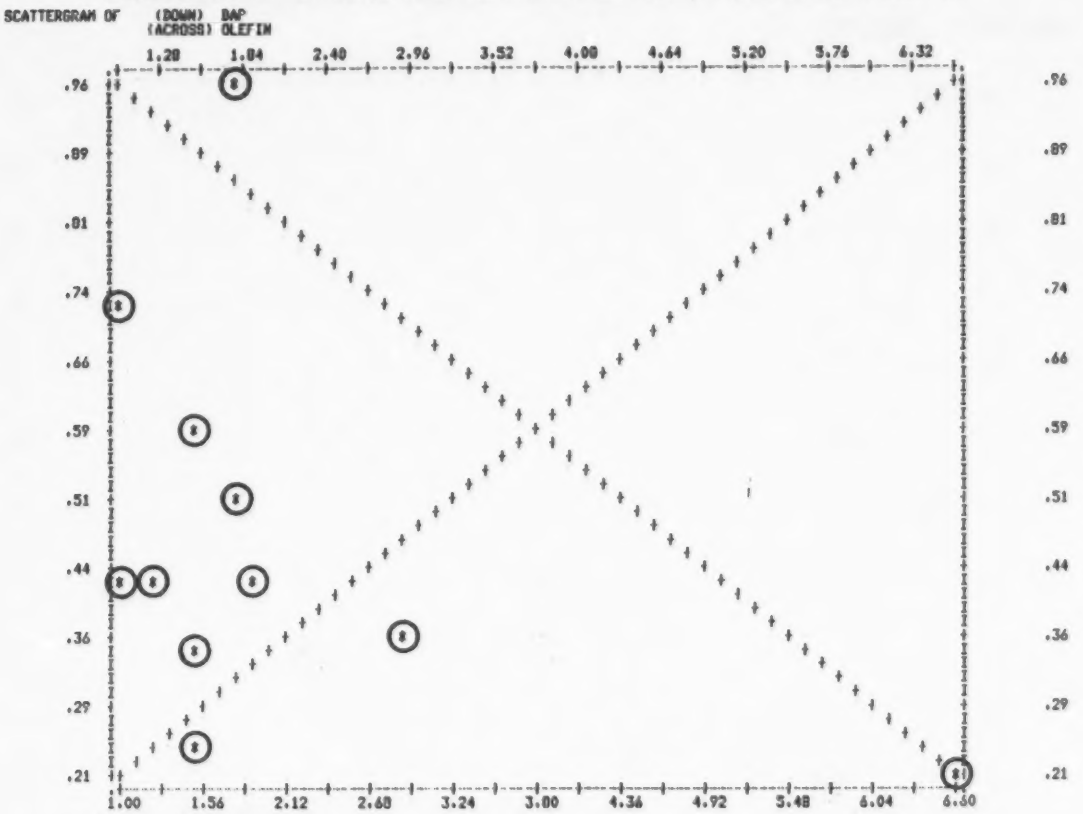
SCATTERGRAM OF (DOWN) BAP
(ACROSS) CETANE#

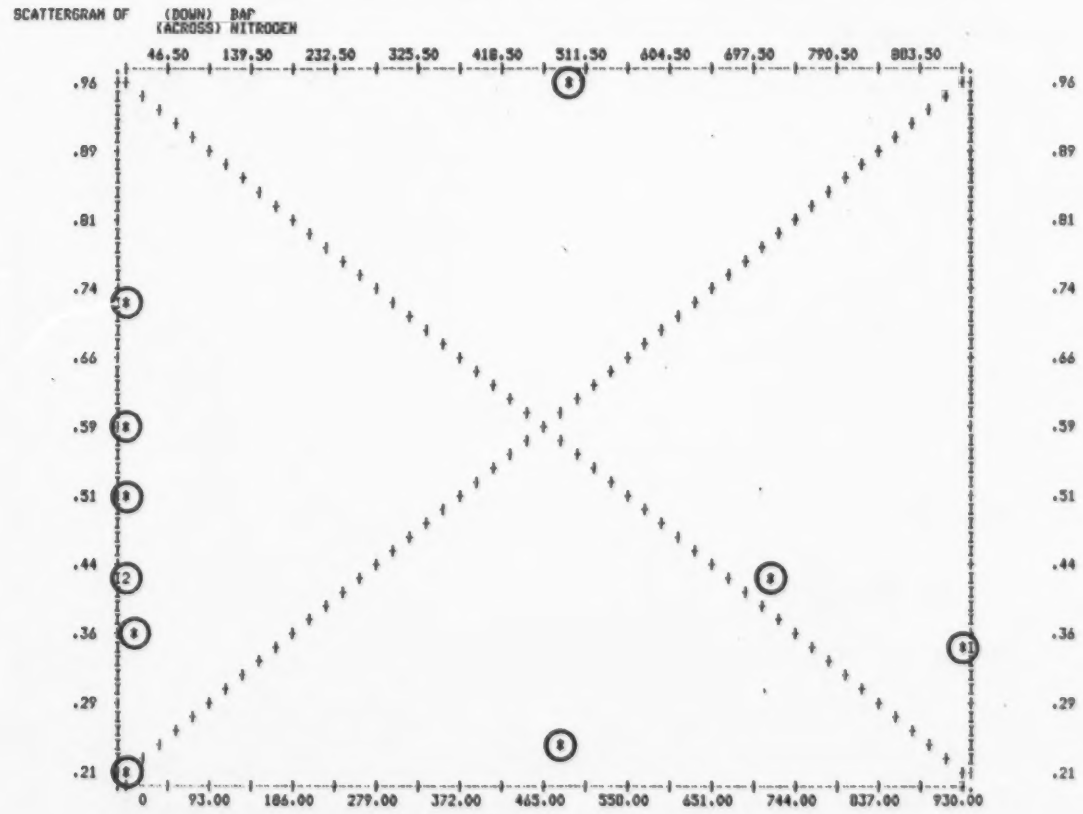


SCATTERGRAM OF (DOWN) BAP
(ACROSS) AROMATIC

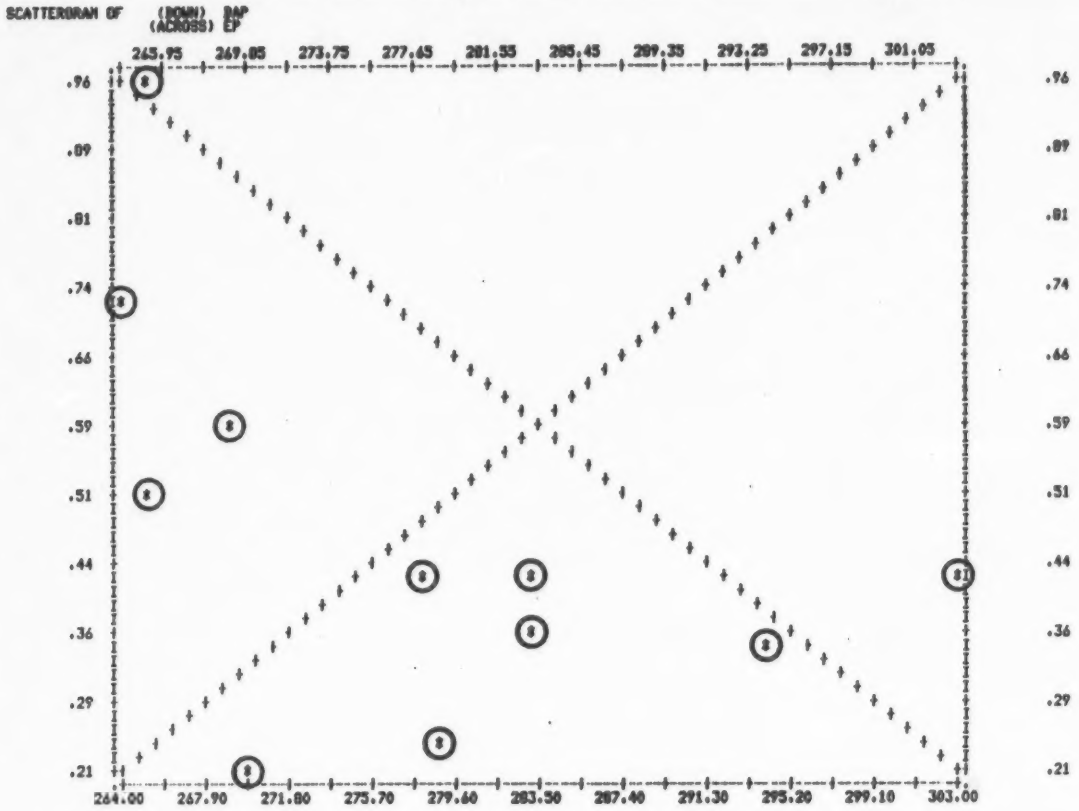


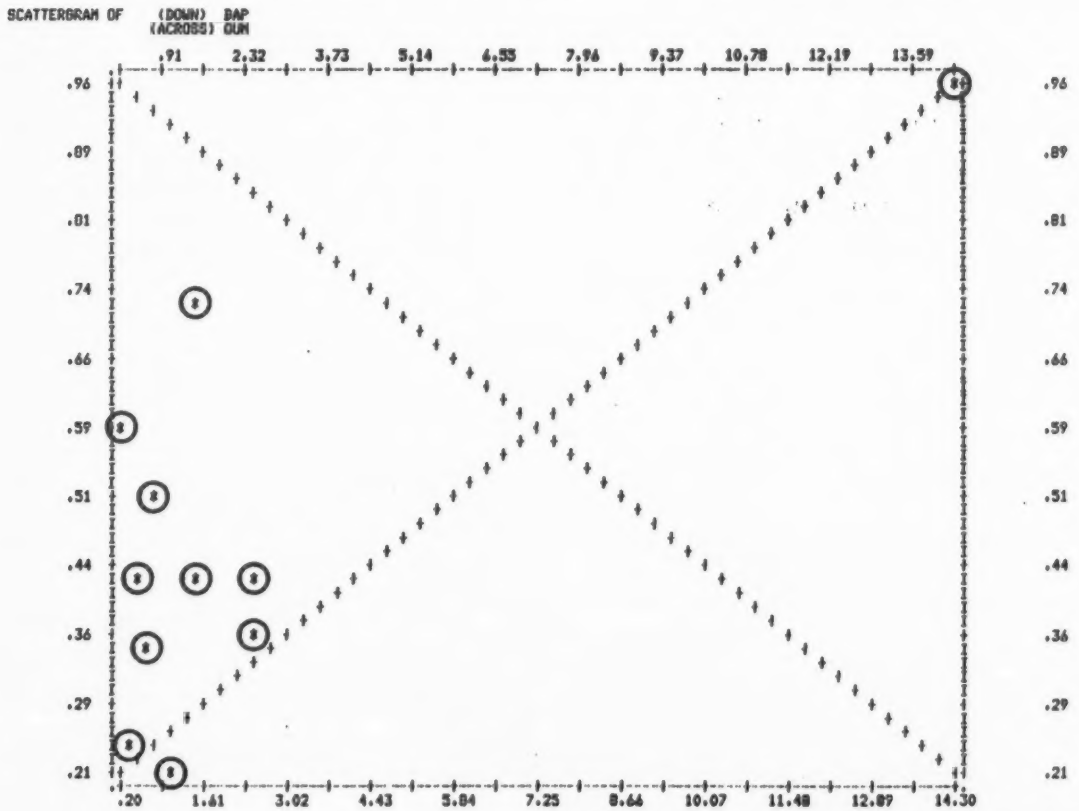
SCATTERGRAM OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)

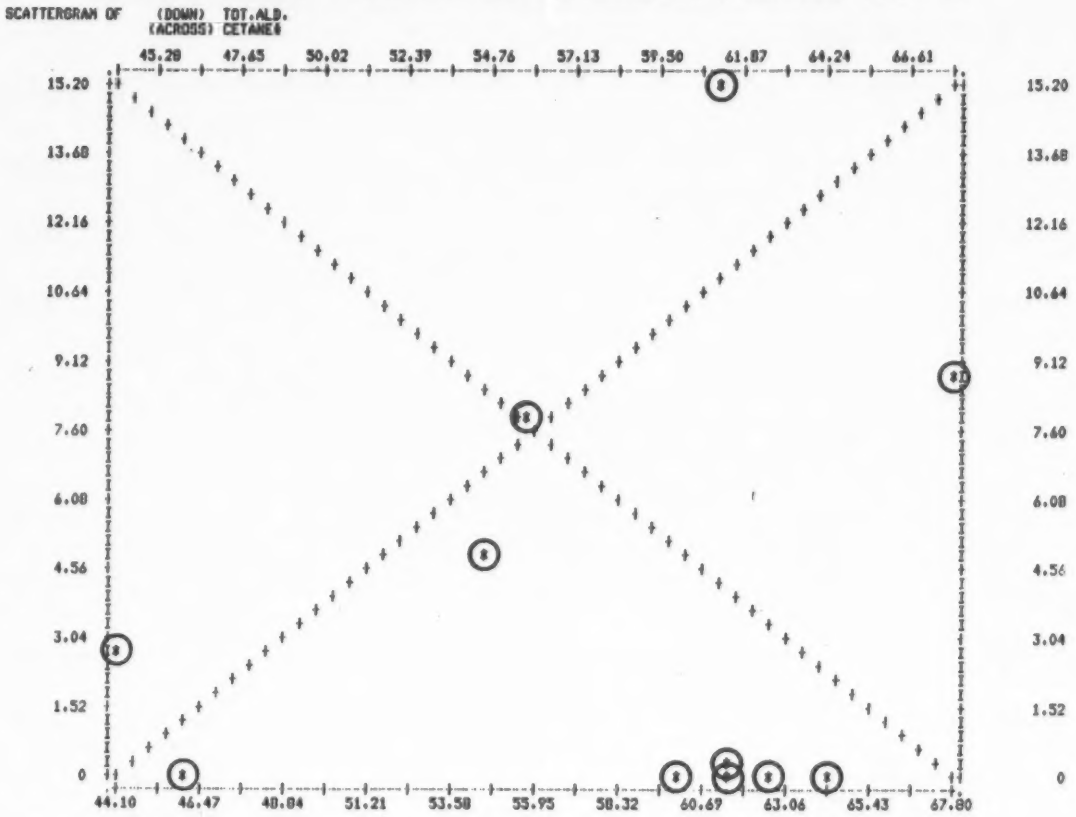


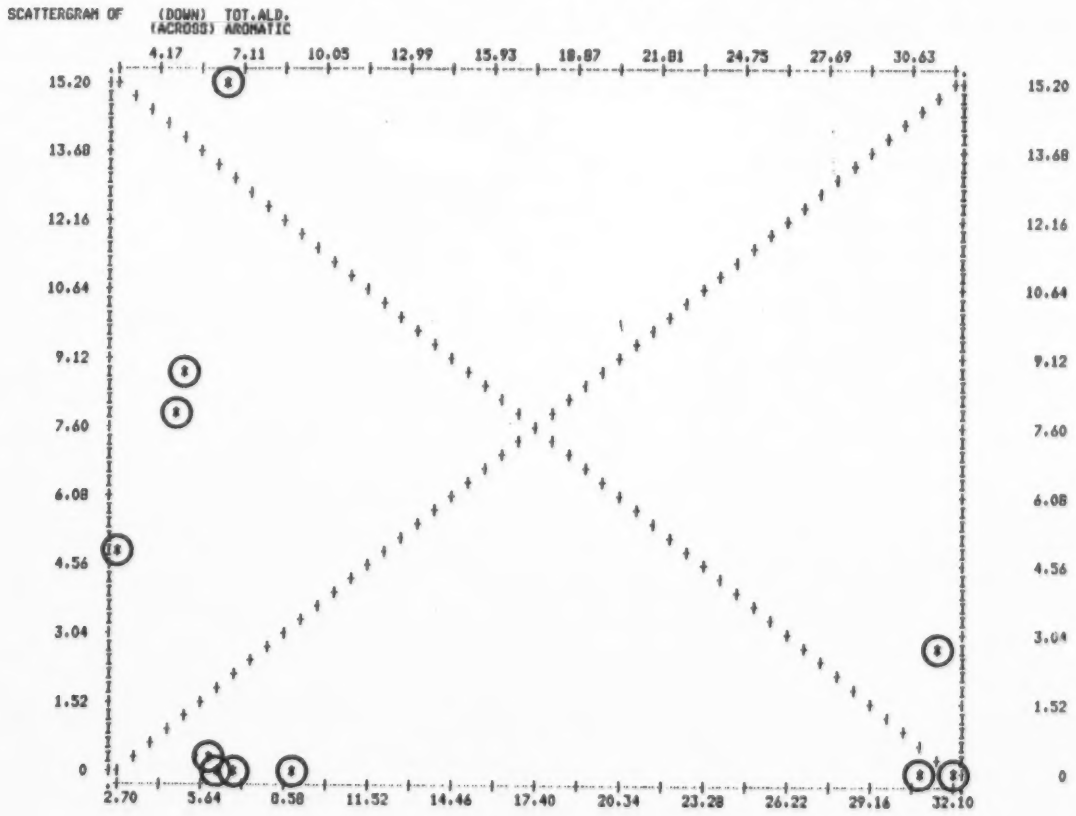


SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)

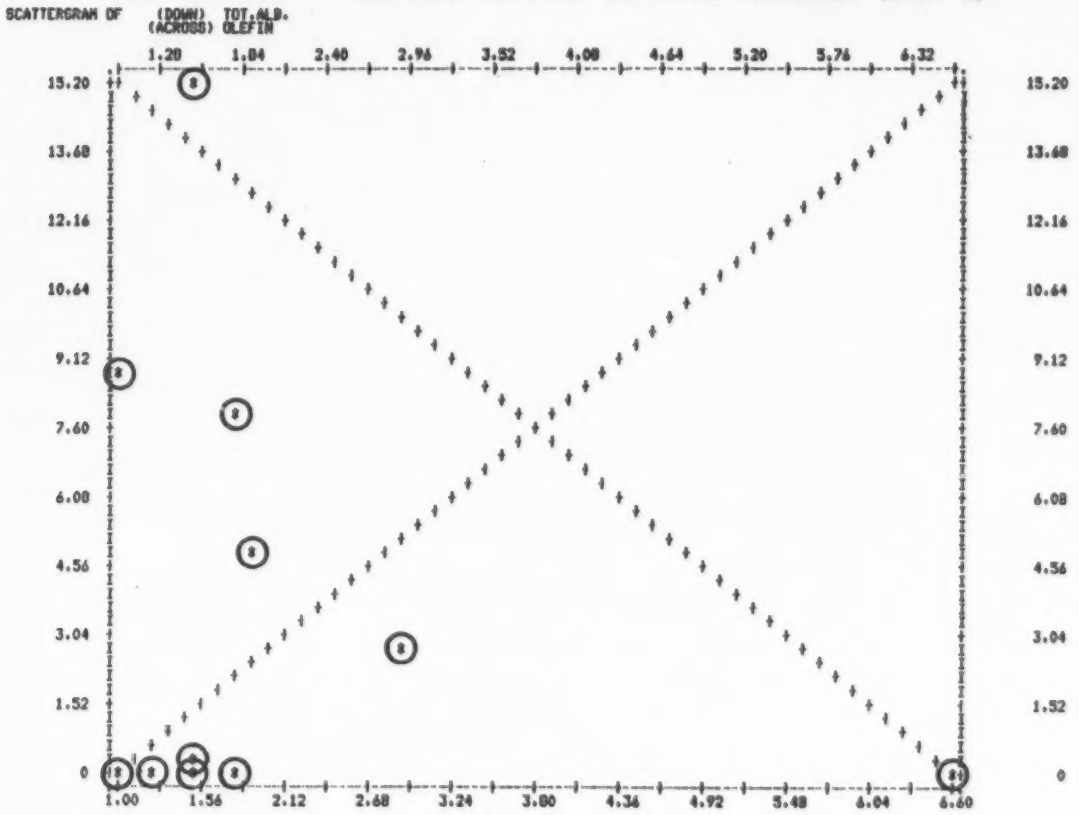


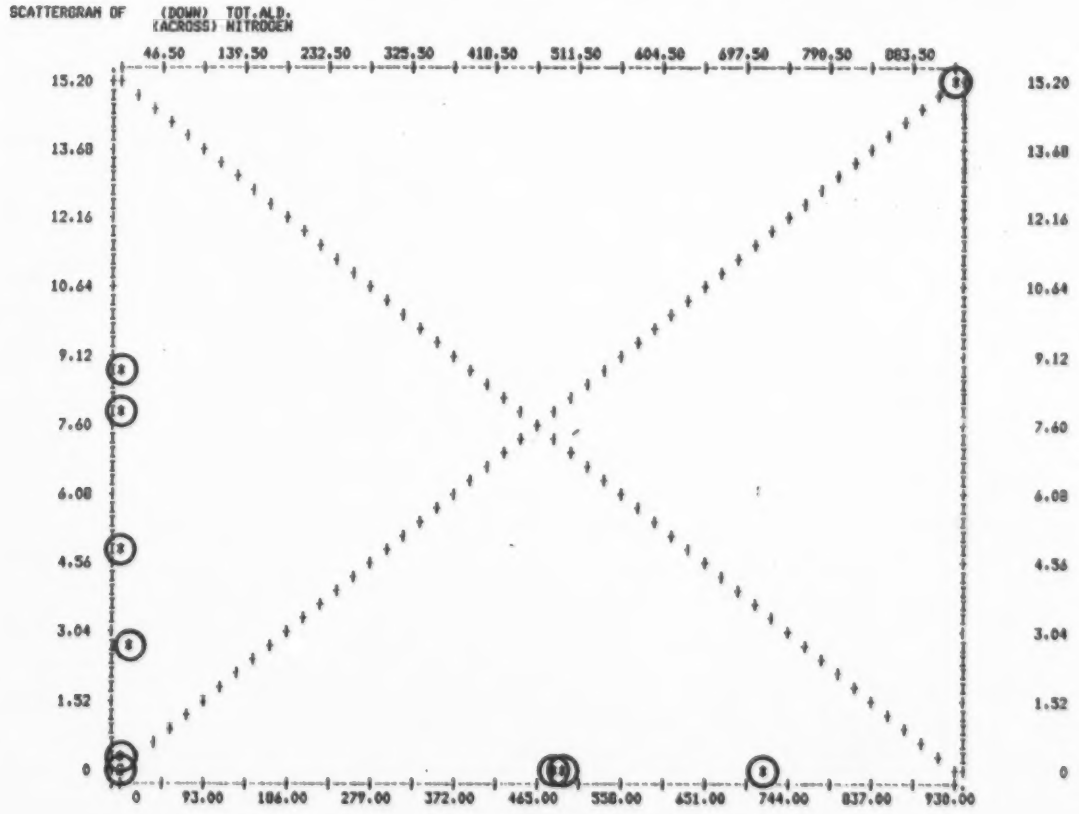



SCATTERGRAM OF (DOWN) TOT.ALD.
(ACROSS) CETANE#
45.28 47.65 50.02 52.39 54.76 57.13 59.50 61.87 64.24 66.61
15.20 13.68 12.16 10.64 9.12 7.60 6.08 4.56 3.04 1.52 0
44.10 46.47 48.84 51.21 53.58 55.95 58.32 60.69 63.06 65.43 67.80

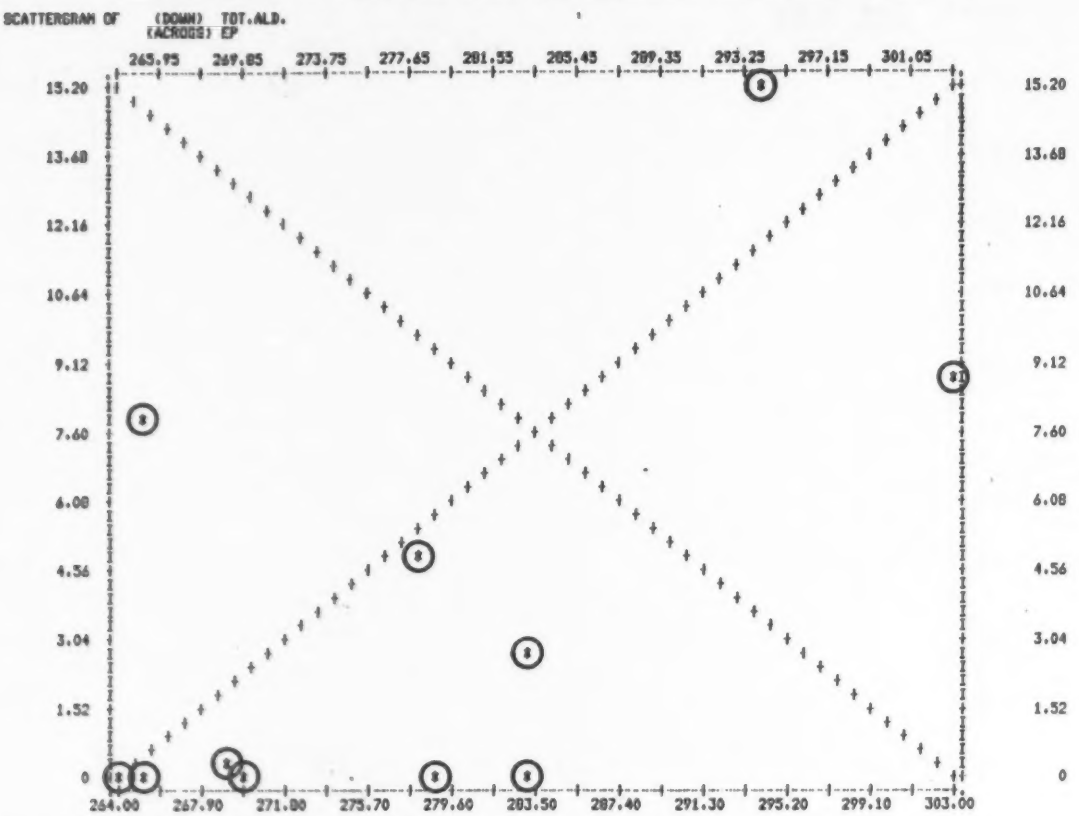

SCATTERGRAM OF (DOWN) TOT.ALD.
(ACROSS) AROMATIC
4.17 7.11 10.05 12.99 15.93 18.87 21.81 24.75 27.69 30.63
15.20 13.68 12.16 10.64 9.12 7.60 6.08 4.56 3.04 1.52 0
2.70 5.64 8.58 11.52 14.46 17.40 20.34 23.28 26.22 29.16 32.10

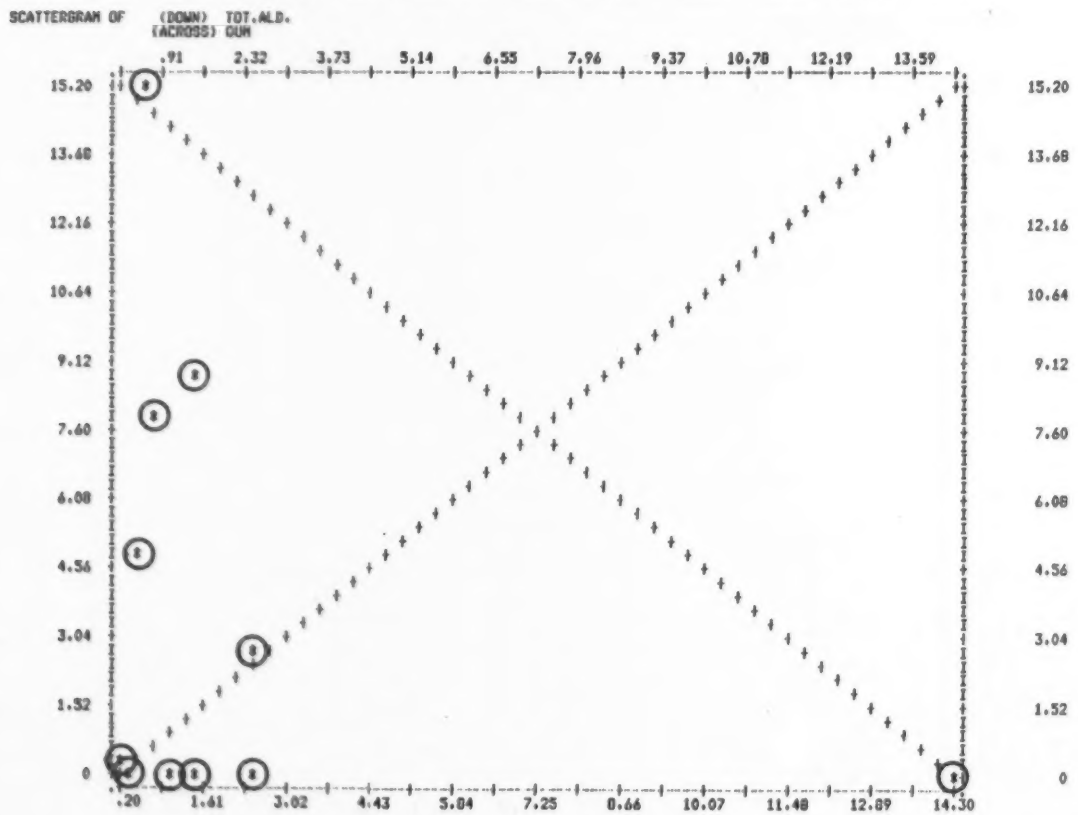
SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)





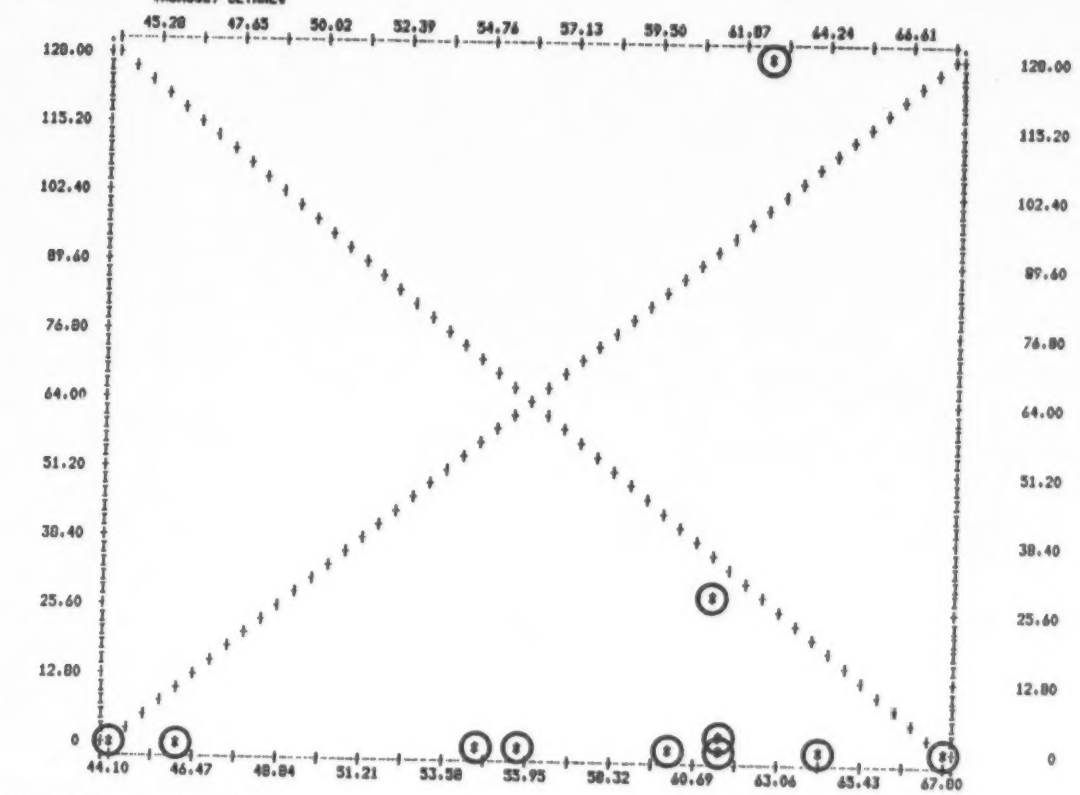
SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)



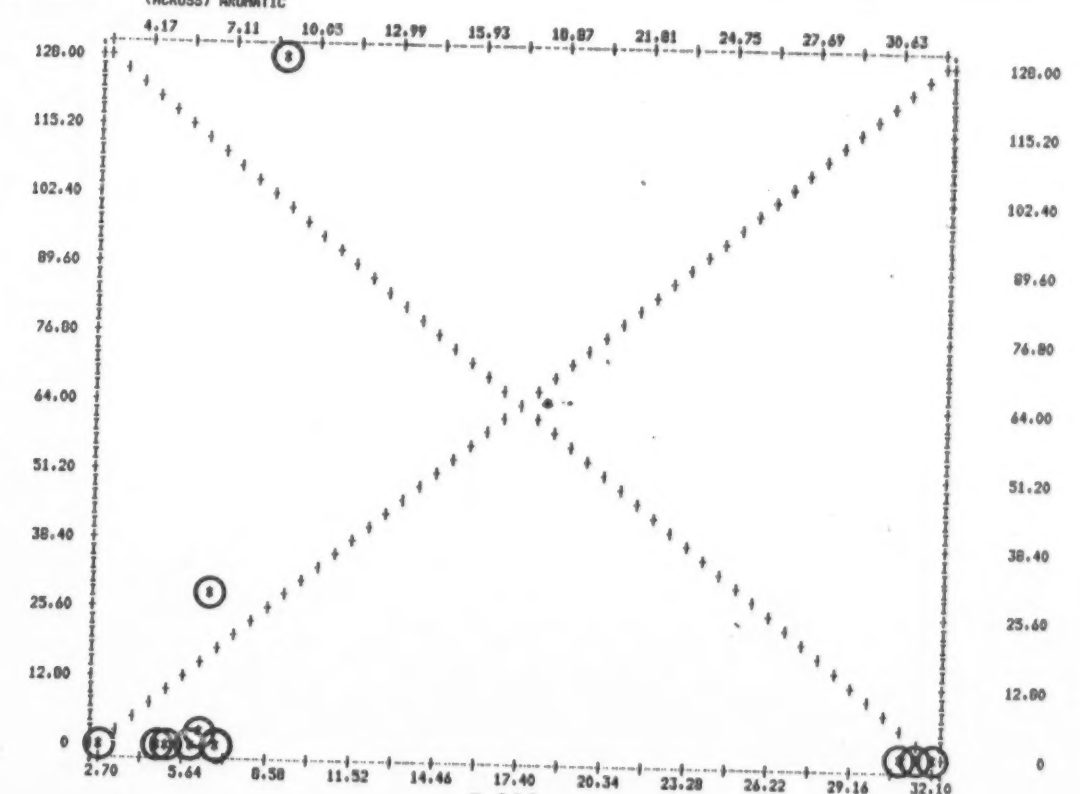


SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)

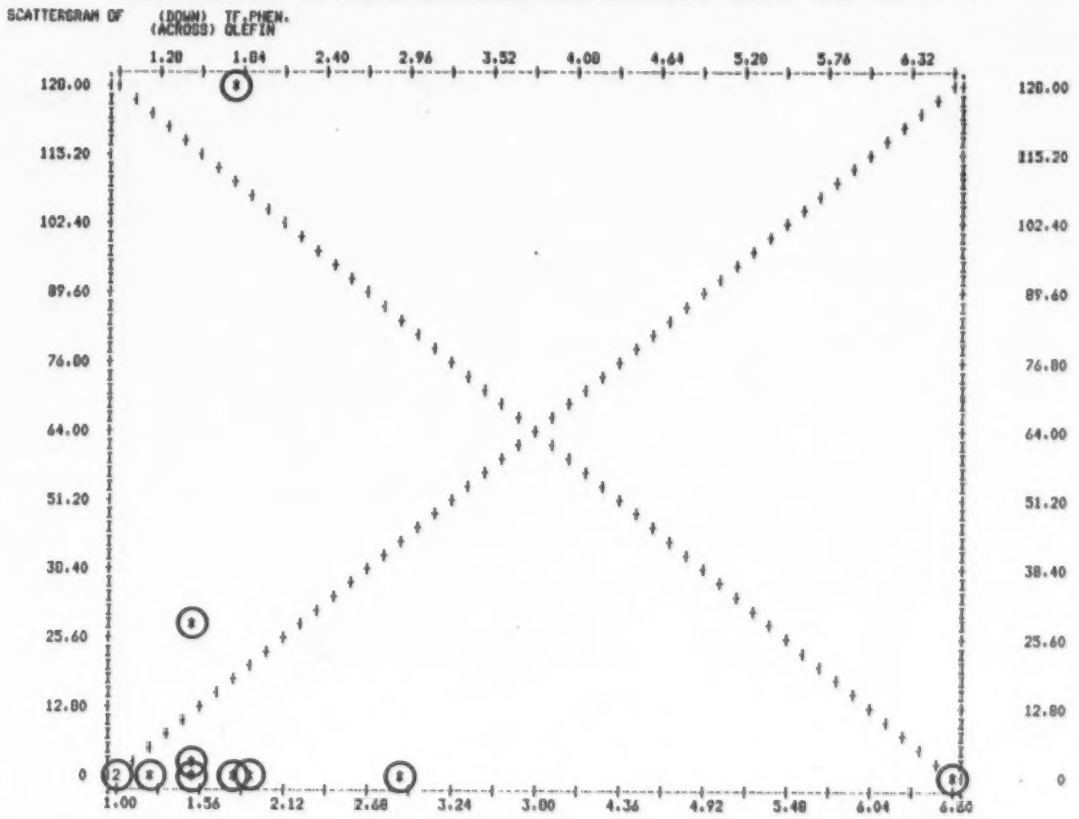
SCATTERGRAM OF (DOWN) TF.PHEN. (ACROSS) CETANE

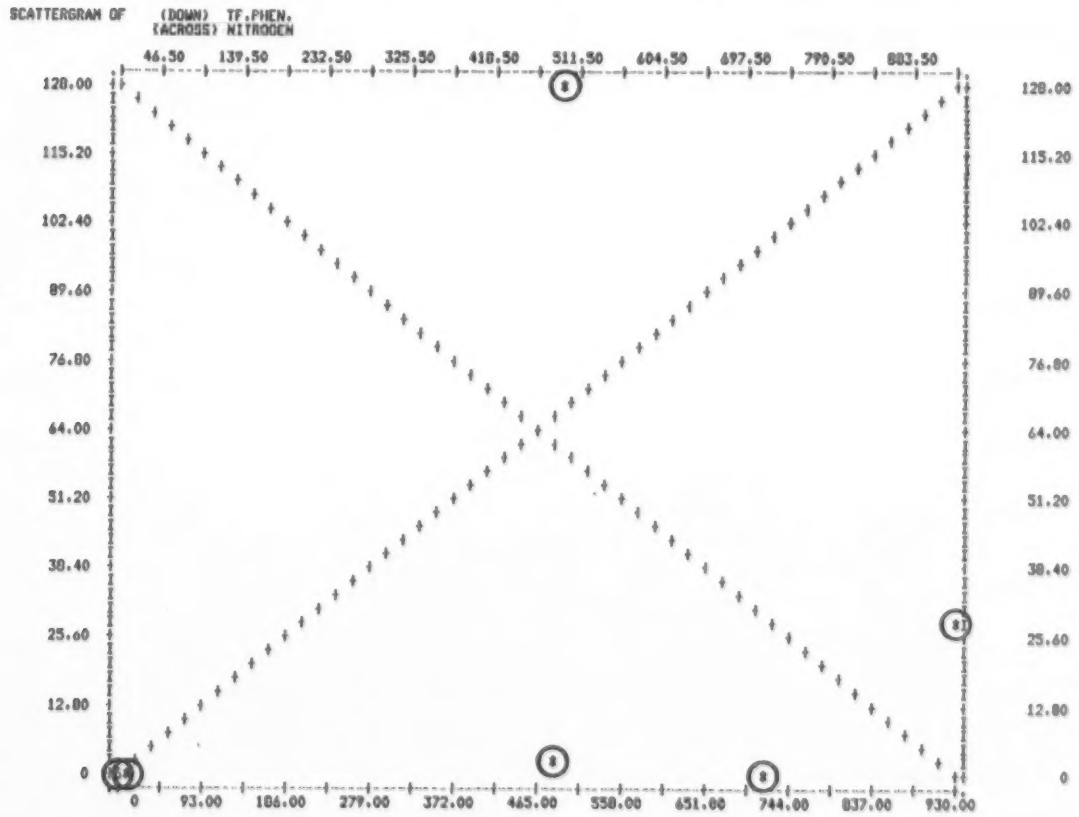
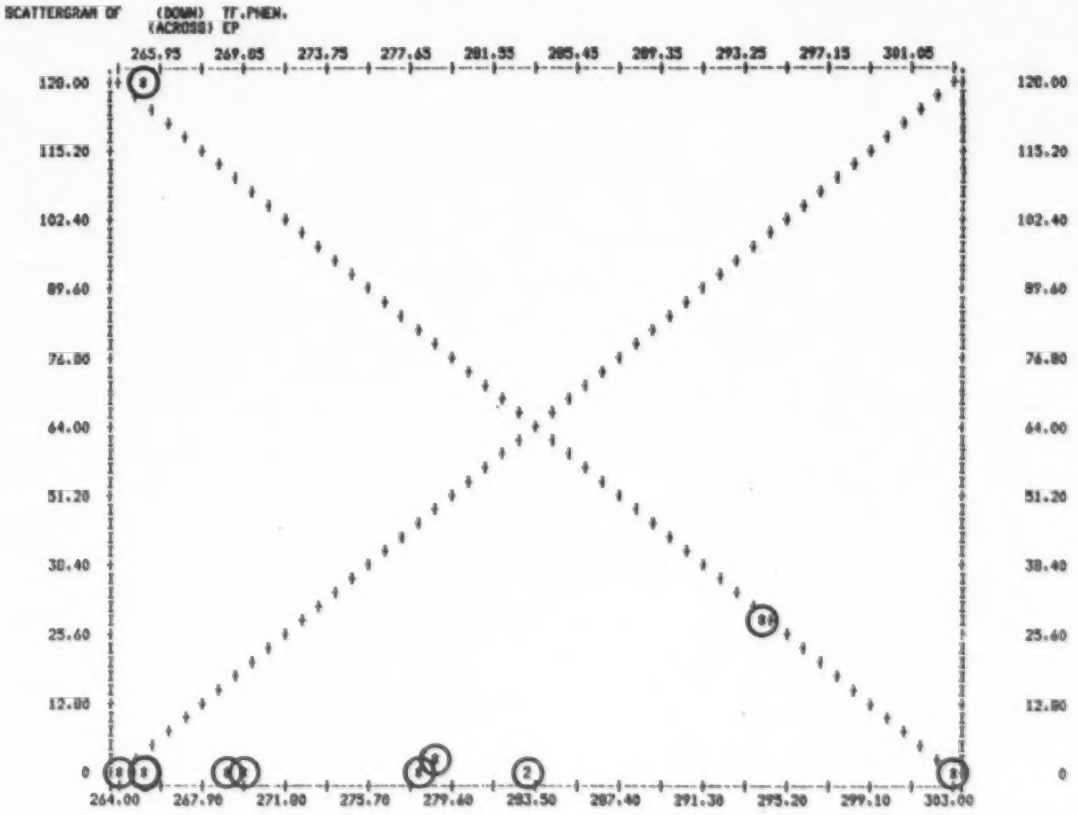
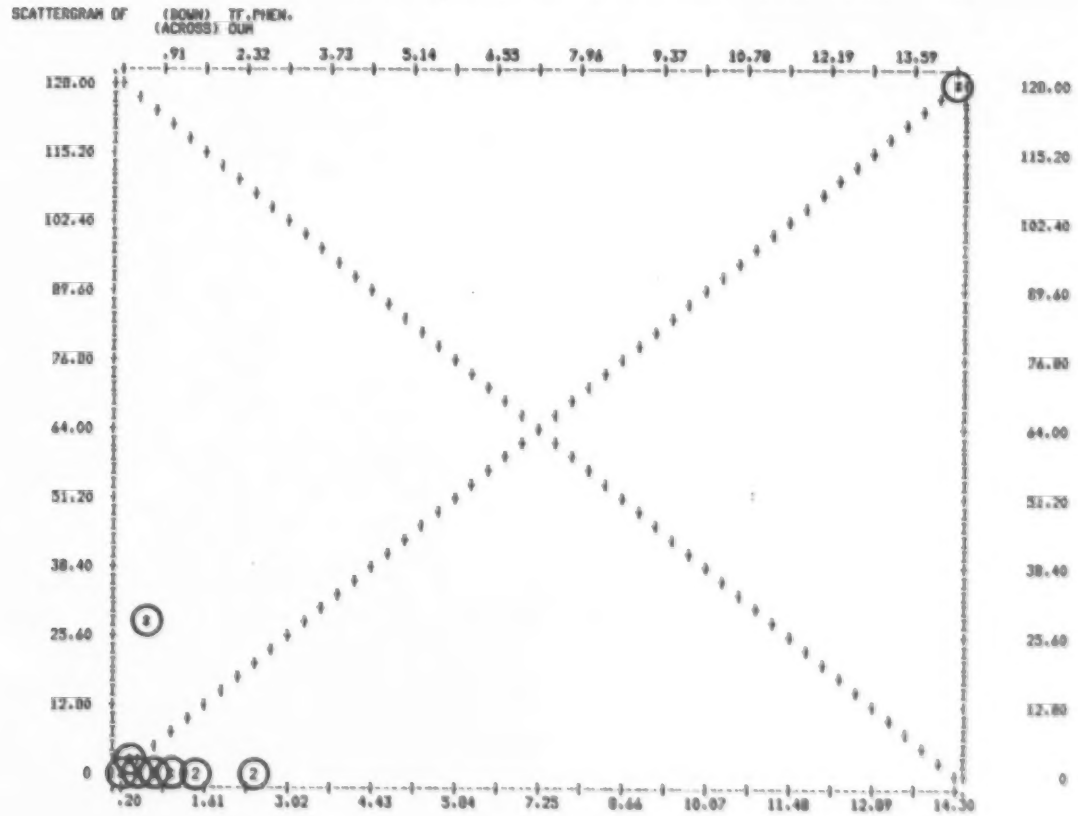


SCATTERGRAM OF (DOWN) TF.PHEN. (ACROSS) AROMATIC



SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)





SCATTERGRAMS OF SELECTED FUEL AND EMISSION VARIABLES (Cont'd)